# REPORT RESUMES

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TECHNOLOGICAL CHANGE AND THE JOURNEYMAN ELECTRICIAN, AN EXPERIMENTAL STUDY IN CONTINUING EDUCATION. VOLUME I.
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DESCRIPTORS- *ADULT VOCATIONAL EDUCATION, TRADE AND INDUSTRIAL EDUCATION, *TEACHING METHODS, *TEACHING MACHINES, TEACHER ROLE, SURVEYS, *ELECTRICIANS, EDUCATIONAL NEEDS, INDIVIDUAL CHARACTERISTICS, EMPLOYEE ATTITUDES, STUDENT MOTIVATION, EXPERIMENTAL GROUPS, CONTROL GROUPS, JOB TRAINING, ELECTRONICS, COMPARATIVE ANALYSIS, PROGRAM DEVELOPMENT, CURRICULUM GUIDES, *EDUCATIONAL EXPERIMENTS, SAN MATEO COUNTY, CALIFORNIA,

THE OBJECTIVE OF THIS STUDY WAS TO IDENTIFY THOSE FACTORS WHICH FACILITATE OR HINDER THE EFFECTIVE TRAINING OF JOURNEYMAN ELECTRICIANS AND TO EVALUATE THE EFFECTIVENESS OF NEW TEACHING AIDS IN TRAINING THEM, IN HOLDING THEIR INTEREST IN VOLUNTARY TRAINING PROGRAMS, AND IN LEADING THEM TO ENROLL IN FUTURE TRAINING COURSES. ALL JOURNEYMAN ELECTRICIANS WHO WERE MEMBERS OF LOCAL 617, INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS, IN SAN MATEO COUNTY, CALIFORNIA, WERE SURVEYED BY MAILED QUESTIONNAIRES TO DETERMINE THEIR ATTITUDES TOWARD TRAINING AND THEIR TRAINING NEEDS. THE EXPERIMENTAL DESIGN CONSISTED OF TEACHING THE COURSE "INTRODUCTION TO INDUSTRIAL ELECTRONICS" TO A GROUP OF 96 JOURNEYMEN INSIDE WIREMEN BY THREE MODES OF INSTRUCTION. THE INSTRUCTIONAL MODES WERE (1) SELF-PACED INDIVIDUALIZED INSTRUCTION USING A BRANCHING TYPE ELECTRICALLY OPERATED TEACHING MACHINE WITH A HIGHLY QUALIFIED JOURNEYMAN ELECTRICIAN WHO HAD NO PREVIOUS TEACHING EXPERIENCE AS A MONITOR, (2) SELF-PACED INDIVIDUALIZED INSTRUCTION WITH AN OPPORTUNITY TO DISCUSS PREVIOUS MATERIAL AND OUTSIDE READINGS WITH AN EXPERIENCED INSTRUCTOR, AND (3) THE CONVENTIONAL CLASSROOM ARRANGEMENT. EACH MODE WAS MADE UP OF TWO CLASSES WHICH MET FOR 3 HOURS ONCE A WEEK FOR 9 WEEKS. THE MODES WERE DESIGNED TO FOLLOW THE SAME SEQUENCE OF INSTRUCTIONAL INFORMATION TO CONTRAST INSTRUCTIONAL PROCEDURES, NOT CONTENT. PRE- AND POST-ACHIEVEMENT TESTS WERE USED TO MEASURE THE DEGREE OF LEARNING. SOME CONCLUSIONS BASED ON DATA ANALYSIS WERE (1) AUTO-INSTRUCTION WORKED AS WELL AS CONVENTIONAL INSTRUCTION, (2) AUTO-INSTRUCTION WITH LIVE INSTRUCTION YIELDED HIGHER STUDENT SATISFACTION, AND (3) THE UNIQUE PROBLEMS OF ADULT EDUCATION REQUIRE INSTRUCTORS FAMILIAR WITH AND CAPABLE OF TEACHING ADULTS. "TECHNOLOGICAL CHANGE AND THE JOURNEYMAN ELECTRICIAN--AN EXPERIMENTAL STUDY IN CONTINUING EDUCATION, VOLUME II," (VT 002 912) PRESENTS INSTRUCTIONAL METHODS USED IN THE PROJECT. (HC)

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*Volume I*

# TECHNOLOGICAL CHANGE AND THE JOURNEYMAN ELECTRICIAN:

## AN EXPERIMENTAL STUDY IN CONTINUING EDUCATION

*Prepared for:*

BUREAU OF INDUSTRIAL EDUCATION
CALIFORNIA STATE DEPARTMENT OF EDUCATION
SACRAMENTO, CALIFORNIA

and

ELECTRICAL CONSTRUCTION INDUSTRY
OF SAN MATEO COUNTY
SAN MATEO, CALIFORNIA

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*March 1963*

*Volume I*

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*SRI Project No. IM-4224*

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# Part I of Volume I

# INTRODUCTION

A worker's initial employment skills are no longer adequate to maintain him throughout his entire employment career. Shifts in demand from blue collar to white collar occupations, from unskilled to skilled employment, and from manufacturing to the service industries require increased readiness to adapt to change--few people will stay in the same job during their entire working careers. Retraining workers whose skills are in danger of becoming obsolete, or who are in danger of being displaced by automation, has become a vital part of the national effort to maintain the current rate of technological growth as well as full employment.

But training effectiveness, particularly in the construction industry, is hampered by at least three factors: the unwillingness of adults to enroll in (and remain enrolled in) voluntary training programs, inadequate techniques for teaching adults, and a shortage of qualified instructors for adult education programs. New ways of motivating adult workers to seek out training opportunities and to sign up for appropriate voluntary programs are urgently needed.

Improvements in adult vocational training programs may hinge in part upon the use of new teaching aids that permit the student to proceed at his own rate of learning and without fear of failure; and in part upon recognition of the fact that adults differ from high school or college students. Recent research has demonstrated that teaching machines are as effective as a "live" instructor in imparting knowledge. The real promise of teaching machines may be their ability to overcome adults' reluctance to expose themselves to the conventional classroom and to possible failure in this group setting.

Self-instructional procedures may offer the advantage of allowing the available qualified instructors to teach more students by utilizing the teachers for that portion of the training which cannot be supplanted by self-instruction alone. What the optimum combination of auto-instructional materials and experienced instructors is, in the field of adult education, has not yet been adequately explored through research. The possibility of using experienced workers who are not experienced instructors, in combination with programed instruction, also warrants study. Experienced workers serving as class monitors might introduce the further advantage of greater awareness of the student's job needs; such persons should gain immediate acceptance by the student group. In some adult education programs, the use of "over-qualified" instructors has led students to conclude that the material being presented is too theoretical; the classes are not geared to the particular needs of the trainees. Thus, by combining the advantages of programed instruction with the advantages of live instruction and, at the same time, by utilizing experienced personnel who might not ordinarily qualify as instructors, the three barriers to successful adult education may be overcome.

## The Background

For the past few years, in cooperation with the Electrical Construction Industry Committee of San Mateo County, jointly comprised of the International Brotherhood of Electrical Workers (IBEW) Local 617 and the San Mateo County Chapter of the National Electrical Contractors Association (NECA), the College of San Mateo has offered a number of courses designed to assist the journeyman electrician in keeping up to date in his trade.

Early in 1962, the State of California's Bureau of Industrial Education, and the Joint Conference Committee of San Mateo County, asked Stanford Research Institute to undertake a study to evaluate the advantages of self-instructional methods in a voluntary adult education program.

SRI conducted the experimental study in the hope that it might serve as a guide to other programs involving the training of workers in a variety of fields.

## The Objectives

The over-all objective of the study was to identify those factors which facilitate or hinder effective training of journeyman electricians and to evaluate the effectiveness of new teaching aids in training journeyman electricians, in holding their interest in voluntary training programs, and in leading them to enroll in future training courses.

The research was designed to answer five questions: (1) When compared with more conventional means of instruction, does the use of new teaching aids in voluntary adult education have a positive effect on achievement? (2) How are journeymen's attitudes toward training affected by the use of new teaching aids? (3) Does the effectiveness of these new teaching aids vary with student ability? If so, how? (4) Can experienced journeymen, who are inexperienced as instructors, work in conjunction with programed instructional devices as effectively as trained instructors who use conventional audio-visual aids in the more common classroom arrangement? (5) What costs are involved in the use of new teaching aids as compared with those of the more conventional approach to training?

## The Procedures

Research in two phases was proposed by SRI to the Bureau of Industrial Education and the Electrical Construction Industry of San Mateo County. In carrying out the objectives of the study, Phase I, completed in May of 1962,[1*] had as its purpose the determination of the feasibility of the proposed research, the review of background materials, the establishment of objectives of the training, and, through interviews with a cross-section of journeymen and electrical contractors, a preliminary specification of training needs.

Phase II, which is reported here, was organized into four steps. The first explored the journeyman's attitudes toward training and his training needs through the development and administration of an attitude questionnaire which was mailed to all members of Local 617.

Step 2 was concerned with the preparation and programing of course materials, the selection and training of instructors, the determination of the most effective teaching aids for presenting the information to be learned, and the detailed development of the experimental design.

The general format of the experimental design consisted of three modes of instruction, each of which was made up of two classes which met for three hours once each week for nine weeks as shown in Figure 1. Of the 27 hours scheduled, 5 were absorbed by tests and examinations, approximately 6 hours by laboratory assignments, and 16 hours by instruction. The modes varied from individualized self-paced instruction to the more conventional group-oriented instruction.

In Mode 1, students were scheduled on a branching type, electrically operated teaching machine for approximately 1-1/2 hours during the first

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* References appear in the bibliography at the end of Volume I.

FIGURE 1

ARRANGEMENT AND LOCATION OF CLASSES FOR THE
EXPERIMENTAL STUDY OF THE INDUSTRIAL ELECTRONICS TRAINING PROGRAM

| Instructional Mode | Class Schedule | Number of Students | Location | Type of Instruction by Allocation of Class Time | | |
|---|---|---|---|---|---|---|
| | | | | Review (1/2 hr) | Teach (1-1/2 hr) | Lab. (1 hr) |
| I | A | 15 | College | P.I.* | P.I. | Live |
| | B | 15 | College | P.I. | P.I. | Live |
| II | D | 15 | College | Live | P.I. | Live |
| | G | 15 | College | Live | P.I. | Live |
| III | C | 18 | Union Hall | Live | Live | Live |
| | E | 18 | Union Hall | Live | Live | Live |

* P.I. = Programed Instruction.

portion of the class. A written review of the previous week's material began each week's program. Weekly review tests for self-diagnostic purposes were administered by a class monitor, a highly qualified journeyman electrician who had not had any previous experience as an instructor. Following the self-instructional portion of the class, the monitor would assign laboratory experiments and equipment for individual and group activity. It was originally intended that 8 hours of laboratory work be assigned in each of the three modes. Only 6, however, were finally scheduled. Students moved through the program at their own rate. Those who moved more rapidly were allowed to spend more time on lab experiments and were also given bonus lessons on the teaching machines.

In Mode 2, students worked on a self-instructional basis but were offered the opportunity to discuss with an experienced instructor on a group discussion basis the previous week's material and outside reading assignments. The discussion replaced the written review in Mode 1. The students then proceeded in a fashion similar to that used in Mode 1, and equal time was given to laboratory work. As in Mode 1, the faster students received bonus lessons.

In Mode 3, students worked in the conventional classroom arrangement; lectures and group discussion served as the basis for instruction. Parallel to Mode 2, the first period of the class was devoted to a review led by the instructor of the previous week's assignments and outside reading. The instructor followed fairly closely the outline of the material that was being presented in the other classes on the teaching machines, and students were given the same laboratory and outside reading assignments.

Because each instructional mode was designed to follow the same sequence of instructional information, each could be described as using programed materials.* The primary purpose of the experimental design was to contrast instructional procedures, not content.

Step 3 involved the actual scheduling and carrying out of the proposed training program. This required recruiting the students and randomly assigning them to one of the three instructional modes; pre-testing the knowledge they already possessed as well as their aptitude for training; and administering a test of the knowledge they gained from the training program.

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* Programed materials can be distinguished from conventionally prepared materials in that each step is carefully sequenced and tested for understanding, before publication, by administering it to a sub-sample of the student population.

In Step 4 the findings were analyzed and reported. This final report is presented in two volumes. The first volume reports in detail the methods and findings and the summary and implications of the study. The second volume provides a complete set of the instructional materials, course outline, and supplementary information.

## Assumptions and Observations

For the purpose of this experimental study, it is assumed that adult students differ from younger students in being more concerned with improving their on-job performance and ensuring their own job security than they are with course grades or degrees. The employed person applies stricter tests of the relevancy of course material to his work than does the full-time student. It is also assumed that the employed person, who over the years has developed a sense of competency in his work, tends to avoid any experience which threatens this sense of preparedness, particularly if it means upgrading his ability to carry out his job.[2] Older adults, with some losses of sensory and physical capacities, may also have less self-confidence about their learning ability.

Generally, the adult is less likely to be influenced by the rewards or sanctions of the teacher. He tends to reject the teacher as incompetent unless the latter demonstrates superior knowledge in the field in which the student is actively employed. The teacher is unlikely to be able to "bluff" his way through an adult education course.

Like the younger student, however, the adult in the classroom is concerned with being accepted by his peers; he is careful not to evidence lack of ability. A sense of pride in being part of a successful training group can result in a heightened motivation to learn, especially if the adult derives status from being a part of this group.

The working class adult, historically, has been characterized by many writers as fearing education. London[3] suggests that, rather than having a fear of education, working class people have merely a negative attitude toward schools; he states that:

> This distortion or confusion about working class values towards education tends to prevent our educators from realizing that more imagination, resources, faith, and quality of instruction must be assigned the task of dealing with working class children and adults to overcome cultural deprivation, lack of success, and limited intellectual experiences that results in inferior school performance.

It has also been shown that in many cases children develop negative attitudes toward education as a result of their early school experiences.[4]

Secondary schools, in the past, have been thought by some educators to provide inadequate education in mathematics. Many adults who were poorly trained in mathematics at the high school level have since that time suffered from a sense of inadequate mathematical background. In 1956, a National Science Foundation survey of recent high school graduates reported that 12 percent had not taken algebra or geometry, an additional 26 percent dropped one or both fields after one year of study, and another 30 percent dropped the subjects at the end of the second year.

Dyer, Kalin, and Lord[5] point out that many present-day teachers "fear" mathematics because of their own inadequate preparation. They also suggest that a double-track program be set up for the student who is not going to college, a mathematics program suitable to his vocation.

Recent research[6] questions the often-stated view that, with age, adults lose their capacity for improving performance through training. The present study was based on the assumption that older people, given sufficient time and appropriate methods, are as capable of developing new skills, of the sort under study here, as are younger persons. This perspective of adult education aided in the design of the research program.

## Acknowledgments

The cooperation and participation of many individuals and groups who contributed to the study are reported here. Appreciation and warmest thanks go first to the many journeymen of Local 617 of the International Brotherhood of Electrical Workers who volunteered their time and effort toward the successful completion of the experimental training program.

Continued support throughout the entire study also came from Mr. Ernest Kramer, Chief, Mr. Richard Nelson, and Mr. Russell Journigan of the California Bureau of Industrial Education. Mr. Journigan provided liaison between the SRI research team and the Bureau.

Mr. Werner Diederichsen, Business Agent of IBEW Local 617, gave much time and effort to the research. Members of his staff were very helpful, especially in the mailings and in the classroom maintenance efforts.

Mr. Robert Coleman, Executive Secretary of the San Mateo County Chapter of the National Electrical Contractors Association, represented the Electrical Construction Industry of San Mateo County and provided the team with helpful contacts among electrical contractors.

Dr. Julio Bortolazzo, President of the College of San Mateo, took part in initiating the study and participated in the September 1962 orientation meeting. Dr. Jacob Wiens and Mr. Bernard Gjerdrum of his staff solved many of the administrative tasks worked out among the College, the Union, and the Institute team.

Perhaps the actual success of the experimental training program relied most on Mr. Morey J. Martin and Mr. Clair Williams, who doubled not only as instructors but were responsible for the selection and design of the course outlines, reference materials, laboratory equipment, and review tests used in the study. Mr. Robert Raabe and Mr. Charles Mendoza, worked closely with the research team not only in the initial development stages but as instructors during the training phase as well.

The programed material presented on the teaching machines was obtained through the cooperation and assistance of Mr. Philip Emerich and Dr. Richard Hatch of U.S. Industries. Mr. Larry Johannsen of Pasadena City College and his staff designed and prepared the TRED equipment used in the conventional teaching. Mr. Lanning Flint, of Bakersfield City College, helped to screen and select programed materials for use in the course. Mr. Joseph Gensiracusa, of San Jose City College, made it possible for the research team to administer the mid-term examination to a "control" group of journeymen electricians.

The research team is particularly indebted to Mrs. Mabel M. Rockwell and Mr. Peter Pipe who served as consultants in the preparation of the programed material. Mrs. Rockwell's experience as an electrical engineer was extremely valuable in the development of the course outline used.

The study was conducted by Mr. David S. Bushnell, social psychologist, under the administrative direction of Dr. Harry V. Kincaid, manager, Behavioral Sciences Research. Special recognition is due Mr. Thomas Connor, who joined the research team after Phase I, monitored many of the evening classes, helped prepare reviews and other material, and assisted in the data reduction and writing of the findings. Mr. Donald Woodworth and Dr. Philip Sorensen, psychologists on the Behavioral Sciences staff, are also thanked for their comments and suggestions at each stage of the research, and Dr. Sheila Ross for her help in the preliminary analyses of initial interview materials and literature reviews.

Several authorities in the field of adult education and programed learning made useful contributions to the initial design and final interpretation of the findings of this research. Among them were Dr. Robert Mager, of Varian Associates; Dr. Jack London, of the University of California at Berkeley, and Dr. Arthur Lumsdaine of the University of California at Los Angeles. To all these people the author acknowledges his indebtedness; he, of course, assumes responsibility for any errors of commission or omission.

# SUMMARY OF FINDINGS

Of the 112,000 or more new journeyman electricians required in the United States by the end of this decade, only 36 percent will be provided through present apprenticeship programs.[7] Less than half of the Joint Apprenticeship Councils (JAC) responsible for apprentice and journeyman training have been sponsoring programs designed to keep the present day journeymen abreast of recent changes, and where such JAC programs have been offered, enrollment has averaged only 12 percent of the active members of the local union.[8] A substantial increase in training of journeymen will be needed to train new recruits and to maintain the level of proficiency of the presently employed journeymen.

## Present Training Practices

Most collective bargaining agreements between the IBEW and the electrical contractors call for a Joint Apprenticeship Committee to organize, administer, and evaluate apprentice and journeyman training programs.[9] Within San Mateo County this responsibility has been assigned to the Joint Conference Committee whose primary purpose is to negotiate the annual bargaining agreement. This committee determines the journeyman training needs within the county and communicates them to the College of San Mateo through the college coordinator of vocational-industrial education. The responsibility for analyzing and appraising the training needs of journeymen in San Mateo County currently rests with the business agent of Local 617 and the Executive Secretary of the San Mateo Chapter of the NECA. For the purpose of this study, SRI undertook to perform these functions.

## Job Requirements

Increased demand for electrical installations in commerce, industry, and private residences has led to a rapid growth in the electrical contracting industry. Data processing equipment, electrical control systems and the larger number of electrical appliances in the home have raised the skill levels required of journeyman electricians.[10] The standards for today's electrical apprentice are higher than they were in the past. This has brought about increased competition between younger and older apprentice graduates for the higher job classifications, such as foremen or estimators.[11]

A detailed job analysis conducted by SRI revealed the knowledge and skill requirements of the journeyman electrician listed in Figure 2. To cover all of these requirements in a one-semester course was obviously not possible. However, a review of the fundamentals of AC and DC electric circuit theory would serve the immediate requirements of two types of journeymen: (1) those who were capable of and qualified for becoming electronic specialists, but who needed remedial training before undertaking more advanced study; and (2) those who required a refresher course but who were not qualified, or motivated, to probe more deeply into electronics.*

## Characteristics of Journeyman Electricians in San Mateo County

Journeyman electricians in San Mateo County vary widely in age, experience, and ability. Sixty-four percent are graduates of apprentice training programs but almost half of this group completed their training in 1950 or earlier.

More than half the journeymen responding to the SRI questionnaire survey conducted in July 1962 had enrolled in one or more adult education courses within the last five years, and, of those that had enrolled, one-third never completed any of the courses they started. Figure 3 reports the reasons given. In general, the journeymen did not value formal education programs as effective ways of learning more about the job. On the contrary, they felt that other experienced men on the job and their own supervisors taught them the most about their present jobs. When asked to judge their own qualifications for handling current job assignments, 70 percent rated their ability as "above average."

Most journeymen seek interesting work and the opportunity to turn out quality work. Seventy-five percent of the respondents hoped for an opportunity to move up to a higher skill level (but still within the classification of journeyman).

Job satisfaction was high; 82 percent of the journeymen responded that they were "very satisfied" or "fairly well satisfied" with their present jobs. This high job satisfaction and feeling of being qualified for

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* While the experimental training program was scheduled to cover the first 27 hours of training, the course continued for the full semester, or 54 hours. The observations and conclusions reported here apply only to the first half of the semester. All students enrolled for the full semester which covered the fundamentals of DC and AC circuit theory.

FIGURE 2

### KNOWLEDGE AND SKILL REQUIRED OF THE JOURNEYMAN ELECTRICIAN

Knowledge of:

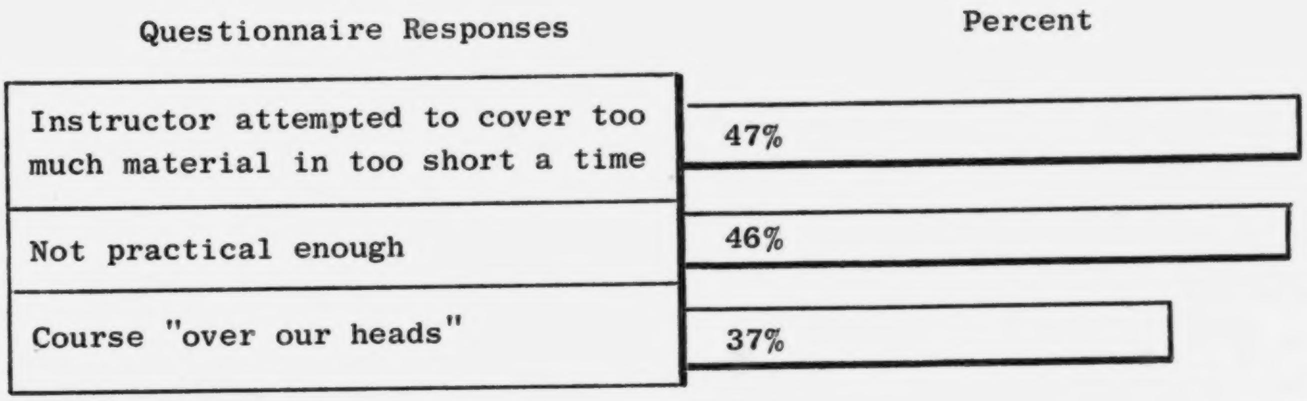
- Fundamentals of DC and AC electric circuit theory
- Symbols and conventions used in electric wiring and schematic diagrams
- Common provisions of, and tables provided by, the National Electrical Code and its local variations
- Safety factors involved in working on industrial, commercial, and residential electrical and electronic circuits
- Elements of vacuum tube and transistor circuitry

Skill or Ability to:

- Make simple electrical calculations based on simple schematic diagrams
- Accurately read an electrical construction blueprint and interpret it in terms of the basic schematic diagrams to which it corresponds
- Use electrical test equipment and interpret the readings of the instruments
- Trouble-shoot lighting, motor, control, and electronic circuits, such as those found in numerically controlled machine tools

FIGURE 3

REACTIONS OF THE JOURNEYMEN TO PREVIOUS VOLUNTARY TRAINING PROGRAMS IN WHICH THEY HAD ENROLLED
(N = 144)



their present job assignments, and their low opinion of voluntary training courses as useful in preparing them to better handle new job assignments, were seen as militating against involvement in a voluntary training program.

The diversity of backgrounds and experience and the previously negative reactions to formal training programs suggested to the research team that a new training program, to be most useful and satisfying, should (1) be job oriented, (2) permit the student to move at his own pace so that he spends his time on those topics on which he is less well informed, and (3) make it possible for the student to experience successful learning at each step of the way.

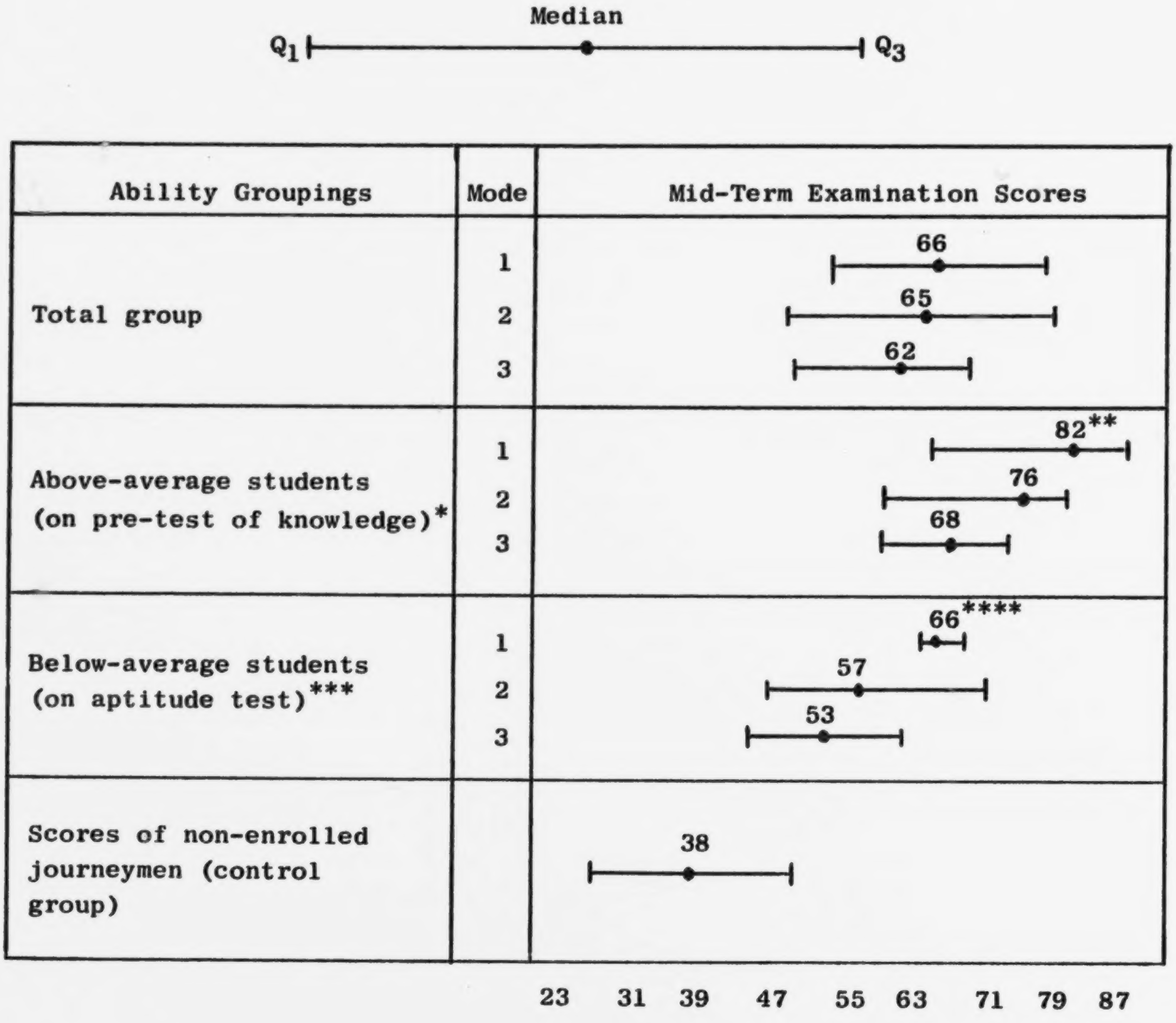
## The Experimental Training Study

### Performance and Attitudes

The students in Mode 1 did only slightly better than those in Modes 2 and 3 on the mid-term examination (see Figure 4). However, those who knew more about the fundamentals of electricity before enrolling in the course, as measured by a pre-test of job knowledge, were able to perform significantly better on the mid-term examination than did those with similar backgrounds in the conventional mode. Lower-ability students also did better in the programed instructional modes (1 and 2) than in the conventional mode (3), although these differences were only marginally significant.

FIGURE 4

QUARTILE DISTRIBUTION AND MEDIANS ON MID-TERM EXAMINATION SCORES FOR EACH INSTRUCTIONAL MODE



* Measuring instrument developed by the research team and administered of first day of class.

** Difference between Modes 1 and 3 significant at the .01 level.

*** Wesman Personnel Classification Test administered on first day of class.

**** Difference between Modes 1 and 3 significant at the .10 level.

Over-all, the training program reviewed the fundamentals of direct current theory in about half the time normally allotted to such a course. This was possible because of the way in which the programed instructional materials were developed; a thorough task analysis and specification of job needs had pared the course down to its essentials. Since the three instructional modes followed the same topical outline of most conventional courses, this saving in time could be attributed to the efficiency of the instructional procedures employed and the care with which the course materials were developed.

As indicated on the attitude questionnaire administered at the completion of the mid-term examination, two-thirds of the students in Modes 1 and 2, combined, said it was easier to learn from the machine than from an instructor. The machine mode by itself, however, (Mode 1) did not result in as high a level of over-all satisfaction with what was learned in the course as did the combined machine and live mode of instruction (Mode 2) as illustrated in Figure 5. Only about a quarter of the Mode 1 group stated they were "very satisfied" with their learning experience, whereas almost half of those in Mode 2 responded in this manner. Other measures of satisfaction with the training program indicated the same results. All of the students in Mode 2 said they would sign up for the same course if it were offered again, as against 79 percent of Mode 1 and 87 percent of Mode 3. Similar numbers of journeymen said they would recommend the course to other journeymen.

Interest in following up with continued enrollment in a subsequent course was also much higher for the students in Mode 2. Eighty-six percent of this group said that they would enroll in a course which continued where this one ended, as against 63 percent in the Mode 1 and 65 percent in Mode 3.

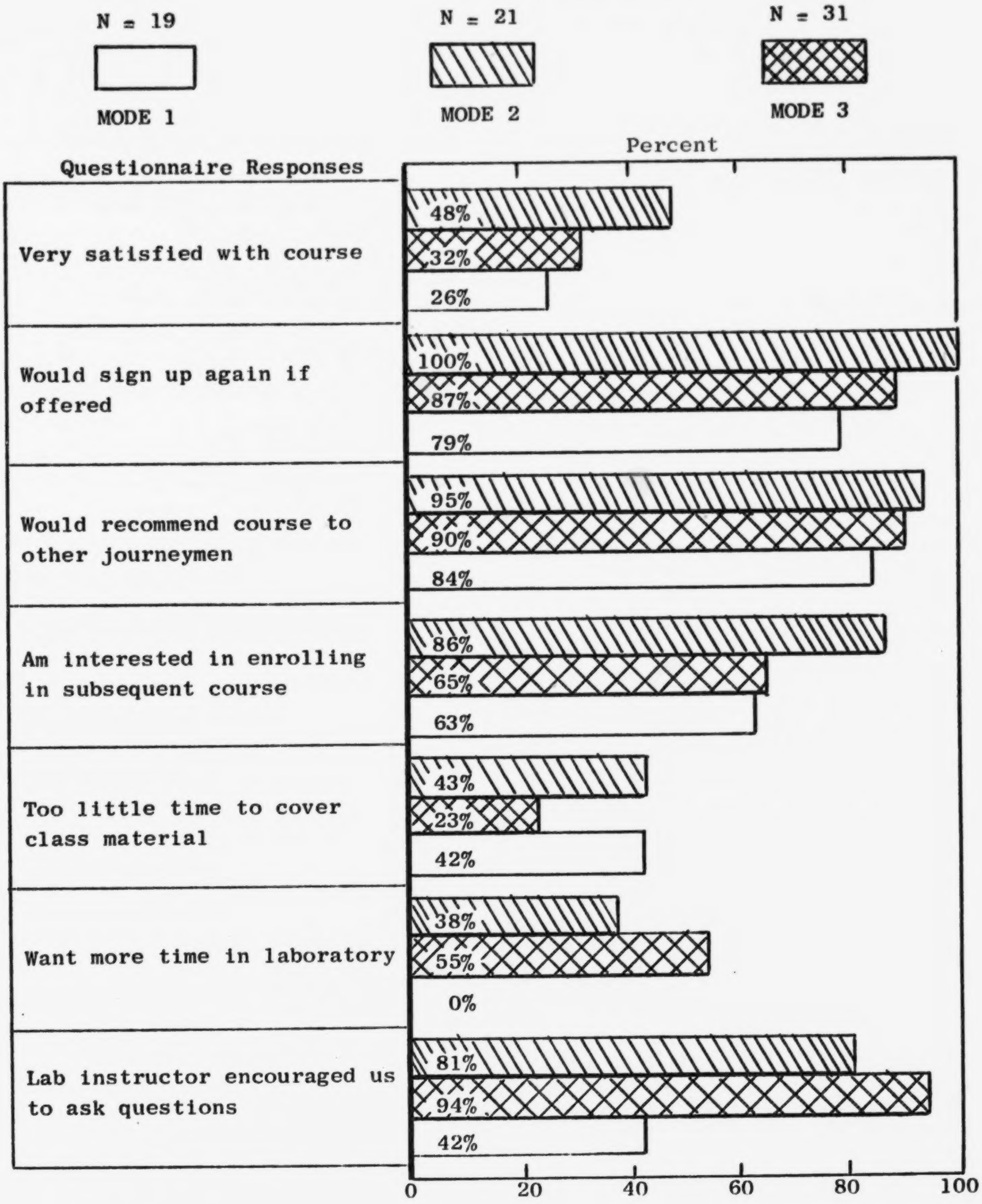
The students in Modes 1 and 2 felt they didn't have enough time to cover the material presented; students in the conventional training (Mode 3) wanted more time in the laboratory. The experienced instructors (Modes 2 and 3) in the laboratory periods encouraged the students to ask questions more frequently than did the inexperienced instructors (Mode 1).

When asked to compare the experimental course with similar courses they had taken, 73 percent of the total enrolled group felt that it was "better." Ninety-three percent found the difficulty of the lessons "about right."

The student group as a whole did not find the course of much value to them on the job. This finding was not unexpected, in that the course was essentially a review of the fundamentals of electricity, although offered as an introduction to industrial electronics.

FIGURE 5

REACTIONS OF JOURNEYMEN TO THE EXPERIMENTAL PROGRAM
(by Mode of Instruction)



### Programing Costs

Adapting a commercially available program to the requirements of the study was found to cost approximately $3.50 per frame for about a thousand frames. Completely rewriting and programing one lesson (100 frames) came to about $12 per frame.

### Absences and Dropouts

The over-all absence rate during the first half of the semester was five percent, excluding ten men who dropped out of the course during this period. There was essentially no difference in absentee or dropout rates between the three modes of instruction during the first nine weeks of instruction.

## Comparison of Enrolled with Non-Enrolled Journeyman Electricians

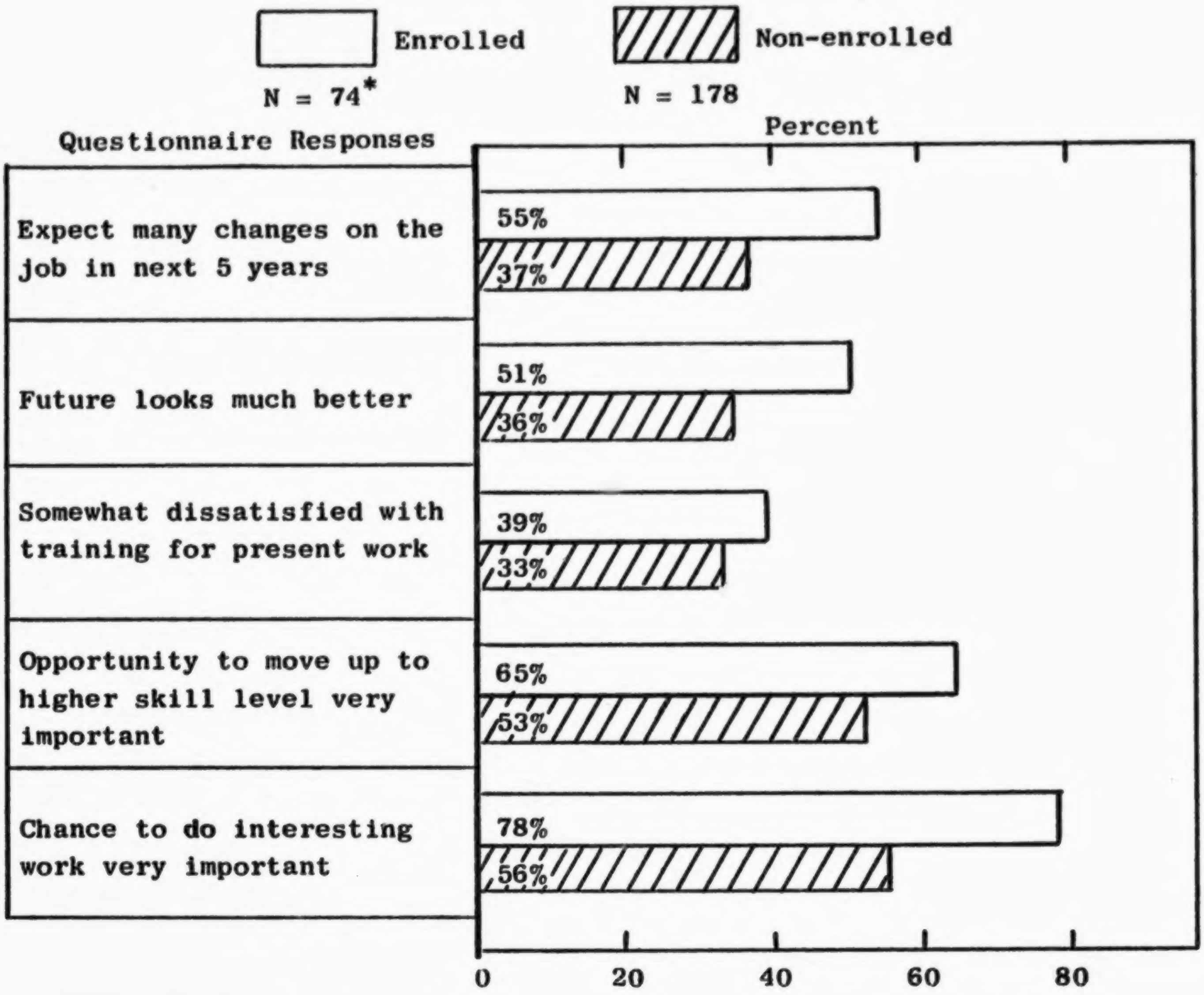
On the basis of the mailed questionnaire survey, the journeymen who enrolled in the training program were found to be somewhat younger, less experienced, and had more family responsibilities than their non-enrolled counterparts. The previous educational experiences of the enrollees tended to be more satisfying, as evidenced by their response to questions regarding their apprentice training and other voluntary training programs. Three-quarters of the enrolled journeymen had taken one or more adult education classes in the last five years, as contrasted with only half of the non-enrolled.

What differentiated the enrolled journeymen most clearly from the non-enrolled group was that the enrolled group expected to see many more changes in their job in the next five years, as illustrated in Figure 6. The enrolled journeymen also expressed greater optimism about their occupational future. Thus, the data indicate that the journeymen who expected changes in the job, and who expected these changes to be beneficial to themselves, were more likely to enroll in a training program than workers who did not feel this way.

The enrolled journeyman tended to be less well satisfied with his current level of training. In general, he hoped to move up to a higher skill level than his current one and he valued the opportunity to do interesting and challenging work.

FIGURE 6

ATTITUDES OF ENROLLED AND NON-ENROLLED JOURNEYMEN TOWARD VARIOUS ASPECTS OF THEIR JOB



* Although the total number of enrollees was 96, only 74 of these responded to the initial survey questionnaire administered in July 1962.

## Recruitment Procedures Used

Almost 25 percent of the journeymen classified as inside wiremen in IBEW Local 617 enrolled in the course. This was brought about by utilizing already established lines of communication in addition to four new communication techniques. The new communication methods which served as additional means for stimulating interest in active participation in the training were: (1) Giving the journeymen an opportunity to take part in specifying the type of training they required, (2) providing them with opportunity to hear a presentation on the proposed training, (3) inviting them to participate in an experiment which was to employ new teaching aids, and (4) setting up competition between the classes through offering a free dinner to that group which had the best attendance record.

The 164 men who had evidenced interest in enrollment in the proposed course on industrial electronics were invited to attend an orientation meeting; approximately 150 did attend, and of these, 96 actually enrolled. This enrollment figure was four times greater than that of similar courses offered previously at the College of San Mateo and at another college in a nearby city.

## The Instructor's Role

One of the purposes of the experiment was to determine whether inexperienced instructors could successfully be linked with programed instruction, thereby providing one way of overcoming the short supply of qualified instructors. The attempt was unsuccessful. Although the journeymen selected to participate as instructors were well qualified as electronics specialists, they failed to encourage questions in the laboratory periods (as shown in Figure 5) and were generally perceived by the students as "less effective" than the experienced instructors in Modes 2 and 3. The hope that the trainees would accept the untrained instructors as being cognizant of their on-the-job needs, and therefore as capable of handling the lab content of the course as trained instructors, was not fulfilled.

## CONCLUSIONS AND IMPLICATIONS

1. In the adult education program studied, auto-instruction worked as well as, or better than, conventional instruction.

Discussion: The presentation of programed material by machine leads to student performance equal to that produced by conventional classroom instruction. This is not an either-or case, however; the most reasonable conclusion is that the educational goals of the experimental program were best achieved through a combination of the two types of procedures. The optimum mix would seem to be approached by machine presentation of material, followed by instructor-led discussion and review, and supplemented by laboratory practice. Skill-building exercise is especially important if principles learned on the machine are to be transferred to performance on the job.

The effectiveness of auto-instruction in remedial training suggests that journeymen who want to qualify for advanced training be assigned to a teaching machine for study outside of the conventional classroom arrangement. At their own speed and convenience, they would complete a prescribed review program. This would ensure more uniform readiness than now exists for entry into advanced programs. Readiness might be judged by means of standardized achievement tests. The advantages of this approach would be: (1) more efficient utilization of instructors; (2) better student preparation; and (3) screening out of those students who should not take, or are not motivated to take, the next step in this self-improvement effort.

Students with more initial knowledge of the subject matter progress more rapidly, and they require additional programed material if they are to be sufficiently challenged. Students who have the potential to progress further into more advanced training warrant individualized attention from the instructor; they can benefit from self-paced instruction offered through the use of modern teaching aids. Slower students, or those with less ability, would also profit from this approach.

2. Auto-instruction in combination with live instruction yields higher student satisfaction with training than does either conventional instruction or auto-instruction alone.

> Discussion: Although auto-instruction may enhance learning by certain types of students, group discussion led by a qualified instructor helps weld the training group together. The addition of discussion provides a more rewarding experience than individual study alone. This combination avoids the limitations introduced by conventional lecture methods. Both slower as well as better qualified students are not penalized by the instructor's having to gear his rate of instruction to the average ability of the group, which is hard to determine within a class as heterogeneous as electricians.

3. Efforts to persuade journeyman electricians to participate in voluntary education programs can be aided by: (1) Emphasizing the beneficial effects of expected job changes; (2) Stressing the importance of being ready to take advantage of these changes; (3) Involving the journeymen in decisions about what should be taught and how they should be taught; and (4) Insuring that the learning experience is a satisfactory one once the journeyman is involved in training.

> Discussion: Awareness and acceptance of change as potentially beneficial is an attitude which can be influenced by already established communication channels. Face-to-face discussions in the union hall or on-the-job do influence a journeyman's decision to take part in training. The local business agent, a fellow worker, and the contractor are all effective persuaders.
>
> Participative decision-making has been established in this study as an effective way of enlisting the support and voluntary participation of a group of workers. Questionnaire surveys and orientation meetings might well be considered as media through which interest and participation can be facilitated.

4. The unique problems of adult education require instructors who are familiar with, and capable of, teaching adults. The study shows that inexperienced instructors in combination with self-instructional devices do not succeed as well as experienced instructors.

> Discussion: The shortage of qualified instructors for voluntary education programs may force junior colleges to consider the development of a full-time faculty whose primary responsibility is

that of carrying out adult education programs. This would offer to this group of educators the opportunity of becoming specialists in teaching adults, a population demonstrably different from that of junior college students.

A full-time staff of this type might also take on the important function of systematically appraising the changing educational needs of key employment groups within a county. Periodic surveys and job analyses carried out by junior college personnel might better meet current as well as future requirements of selected occupational groups.

5. Commercially available programs for presentation on teaching machines can be satisfactorily adapted to the requirements of a particular student group at a cost considerably below that incurred by in-house programing.

Discussion: Adapting a commercially available program to the needs of the journeyman electrician cost approximately \$3.50 per instructional frame as contrasted with \$12 per frame incurred by the research team in completely reprograming one lesson of the course.

Coupling live instruction with programed instruction on machines costs more, but should be measured against the potential savings in time. Cutting the number of instructional hours by 40 to 50 percent and prorating the expense of programed instruction over a larger student body may bring it within the realm of current costs per student per unit of conventional instruction. This offers the added advantage of a shortened course with greater resultant appeal to adults.

## Part II of Volume I

## Chapter 1

## THE APPROACH

In Phase I of this study a preliminary series of interviews with journeymen and electrical contractors suggested that the following general categories of information be explored:

1. Type of work currently engaged in, perceived changes in the last five years, and changes anticipated during the next five years;

2. Background factors (age, education, types of leisure activities, length of time in present classification, etc.);

3. Career aspirations (type of work informant hopes to be doing five years from now);

4. Feelings about adult education generally and about courses enrolled in during the past five years;

5. Satisfaction with present job assignment and contributing factors;

6. Attitudes toward previous training and experience;

7. Types of courses interested in and willingness to enroll in a course on industrial electronics.

Volume II presents the schedule of interview items and a summary of the results.

Prior to setting up the actual experiment, the opinions, interests, and attitudes of the membership of IBEW Local 617 were surveyed by mail. The questionnaire consisted of 36 items (see Volume II) and was pretested on 25 journeymen selected at random. After revision, the questionnaire was mailed to the 415 journeymen in the local who qualified as inside wiremen. The total response was 270, or 65 percent.

From the 270 respondents, 163 indicated they were interested in enrolling in the proposed course on industrial electronics. This group was invited to attend an orientation meeting a week before classes began. Approximately 150 attended, with 96 accepting the invitation to enroll. These were randomly assigned to six separate classes, each ranging in size from 15 to 18 students.

The subject of the course, entitled "Introduction to Industrial Electronics," was essentially a review of the fundamentals of electricity, a necessary preliminary step to more advanced training in electronics. In the six classes, three different modes of instruction were employed. Figure 1 illustrates the modes, the number of students, the place, and the organization of the subject matter.

"Before" and "after" measures were administered to the 96 students, the latter at the midterm point when the formal experiment was concluded, with all students continuing until the end of the semester. Attitude questionnaires and achievement measures were used to compare the relative effectiveness of the three modes of instruction. The scores of the experimental groups were compared with scores of a randomly selected group of journeymen who had not participated in the retraining course.

## Preparation and Programing of Course Materials

After analyzing the job needs and the expectations of those journeymen who had indicated an interest in enrolling in the proposed course, the research team reviewed existing course outlines to determine which of several best met these needs. One program was found that did meet most of the requirements. It had been developed for Air Force technicians[12] (see Volume II for a complete description of the course content), and was adapted to the needs of the study.

Approximately 1,100 frames,[*] covering the 15 instruction hours of the experiment[**] were selected for use on a teaching machine. (Chapter 4 describes in more detail the procedures followed in selecting the self-instructional device and in revising the program and the materials used.) Identical laboratory experiments and equipment, outside reading assignments, and weekly review tests were also incorporated into the curriculum for each of the three instruction modes employed.

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[*] A frame presents information which, since it stands by itself in a sequence, is usually a separate page or slide.

[**] In all, 54 classroom hours were scheduled for the course. Of these approximately 18 hours were to be spent in lab. The period of the study extended through the first 9 weeks, or 15 instructional hours, 7 lab hours, and 5 hours for testing.

### Determination of Instructional Modes

The three modes of instructions employed varied from group-oriented to more individualized instruction. In Mode 1, students were scheduled on the teaching machines for approximately 1-1/2 hours during the first portion of the class. Distribution of a written review of the previous week's material and outside reading assignments began each segment of the program. Midway through each evening, the students took a ten-minute coffee break, following which the class monitor assigned laboratory experiments and equipment for group activity. Students moved through the program at their own rate. Those who moved quickly through the prescribed material were allowed to spend more time on lab experiments and were also given additional lessons on the machines.

In Mode 2, students worked on an auto-instructional basis but were offered the opportunity at the beginning of class to discuss with a live instructor the previous week's material and outside reading assignments. (The live discussion replaced the written review in Mode 1.) The students then proceeded in a fashion similar to that used in Mode 1, with equal time given to laboratory work. As in Mode 1, the faster students received extra lessons to take up the slack.

In Mode 3, students worked in the conventional classroom arrangement; lectures and group discussion served as the basis for instruction. Parallel to Mode 2, the first half-hour was devoted to a review by the instructor of the previous week's assignments and outside reading. The instructor followed as closely as possible the outline of the material that was being presented in the other classes on the teaching machines, and students were given the same laboratory work and outside reading assignments. (For a more detailed description of the experimental design employed in the study, see Chapter 7.)

### Selection of Equipment

The task of selecting the most appropriate type of teaching machine from among those available commercially required careful study of alternatives. Whether to use (1) a simple linear-program machine requiring a constructed or write-in response or (2) a branching program with multiple choice responses was determined by the learning task, by the type of students, and by the availability of a pre-programed course on industrial electronics. The AutoTutor machine* which employs a branching mode of programing was selected. Some consideration was given to the possibility of using a programed text book but was rejected (see Chapter 4).

## Criteria Measures

Pre- and post-achievement tests were developed to measure the degree of learning achieved by the training program (see Volume II). The pre-test measure contained 32 items and required approximately 1 hour to administer. The reliability was .97.

The mid-term examination, consisting of 99 test items, was designed to be administered in a two-hour period; it was used to determine the effectiveness of the training at the mid-point of the semester. The reliability of the mid-term exam was .96 and the correlation with the pre-test was .65.

An attitude questionnaire was administered immediately following the mid-term examination. Questions were asked about the laboratory portions of the class, the weekly review tests and hand-out reviews, the class lessons, and lastly, where appropriate, the teaching machines. Volume II of the report contains copies of each criterion measure.

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* AutoTutor Mark 2 machine is manufactured by U.S. Industries.

# Chapter 2

# THE SETTING

The United States labor force is expected to expand during this decade at an average rate of 1.2 million per year. A parallel growth in construction work may result in a sharp increase in the number of workers employed in construction occupations. By 1970, 4.2 million skilled workers in the building trades are expected to be employed--an increase of 50 percent over 1960.[7]

Of the approximately 130,000 journeyman electricians presently employed in the construction trade, some 32,000 are expected to retire, die, or shift to other occupations by 1970; a projected 80,000 additional journeyman electricians will be needed by 1970. This will result in a requirement for the training of a total of 112,000 or more new journeyman electricians by the end of the decade. If apprenticeship programs continue at their present level, only 40,000, or 36 percent, of the required number will be provided in this manner. This leaves some 72,000 new journeymen to be trained through other means; therefore, to train new recruits and at the same time maintain the level of proficiency of those already employed, a substantial increase in effort will be necessary to train both apprentices and journeymen in the building trades.

In a nationwide study of the electrical construction industry conducted by the Bureau of Apprenticeship and Training,[8] only 40 percent of the Joint Apprenticeship Councils contacted were offering programs designed to keep the journeymen abreast of new construction materials and techniques and new types of test equipment. An increased demand for trouble-shooting and maintenance skills has produced a greater need for continuous training of journeyman electricians than in any other sector of the construction industry; three times as many courses in basic electronics were being offered as in any other subject. Enrollment in all journeyman electrician programs, however, averaged only 12 percent of the active members of the local unions.

Present journeyman training programs vary in length from 6- to 144-hour courses. Since journeymen usually attend on their own time, most classes are offered in the evenings and during the winter months. For the most part, journeyman electricians or local vocational educators are recruited as instructors.

From this brief review, it is clear that a considerable growth in the volume of both journeyman- and apprentice-training courses will be required. Any insights on new ways to attract journeyman electricians into a training program will be of use to vocational educators who are concerned with the training of apprentices and others recruited directly into the ranks of journeymen.

It is the responsibility of the National Joint Apprenticeship and Training Committee for the Electrical Industry, which operates under the joint sponsorship of the NECA and the IBEW, to promote apprenticeship and training in the electrical industry. National apprenticeship and training standards for the electrical trades have been formulated and adopted by the joint committee in accordance with standards recommended by the U.S. Department of Labor's Bureau of Apprenticeship and Training.[9] Local Joint Apprenticeship Committees (JAC) work closely with both the unions and the contractors to promote effective training practices throughout the industry in order to ensure the development of a highly skilled work force. In the survey conducted by the Bureau of Apprenticeship and Training in 1958, 490 wage areas* were contacted in 48 states and Hawaii, including the District of Columbia, that cover about 95 percent of the unionized sector of the electrical contracting industry. Over 80 percent of the 490 areas surveyed had active joint apprenticeship and training committees.

Each JAC in the electrical contracting industry is usually made up of three union members and three contractors who serve without compensation; provision for such committees is usually in the collective bargaining agreements. It is the responsibility of JAC to organize and administer, on the basis of the needs of the local area, the apprentice and journeyman training programs, in conformity with standards developed by the national Joint Committee and of the federal and state apprenticeship agencies. The standards provide for a systematic method of training apprentices and describe such aspects of the program as the schedule of work processes, the related instruction to be covered, the wage rate during apprenticeship, the procedures to be used by JAC members in carrying out their responsibilities, and other relevant matters. In some areas, the responsibility for journeyman training is less well developed.

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* A wage area is defined as that which includes the jurisdictional limits of a local union or of a group of local unions in the collective bargaining relationship with employers or employer groups. Such an area usually has well defined geographical boundaries.

In San Mateo County, JAC does not carry the responsibility for journeyman training; it has been given to the Joint Conference Committee (JCC) whose primary purpose is to negotiate the annual contract. Comprised of union and contractor representatives, the San Mateo JCC determines the county's training needs and communicates them to the College of San Mateo through the college coordinator of vocational and industrial education.

Journeyman electrician training needs are judged in a variety of ways. For example, upon learning recently that the production of electrical power is expected to double within San Mateo County in ten years, JCC was able to project to the end of the decade the number of qualified journeymen required and the types of training needed. Trade shows, magazines, manufacturers' agents, and distributors give advance notice of new types of equipment and materials; this permits the JCC to determine the skills and knowledge that will be required by the journeymen. Individual contractors also know, from the types of jobs they bid on, what skills they will require and make these requirements known through their representatives on JCC.

The JCC may arrange a demonstration of the new equipment or materials, and, if it becomes evident that the journeymen will require more extensive knowledge of this development, JCC arranges for an instructor to work with a roster of selected journeymen so that each contractor will have someone in his group who is capable of working with the new equipment. On occasion, the manufacturer provides this instruction either in the form of lesson outlines or through a company instructor.

For more extended training programs, such as that contemplated in the industrial electronics area, JCC may ask a representative of the College of San Mateo to a meeting in which the committee works with the representative to establish a course outline. The JCC also helps in the selection of an instructor. Through the college's Extended Day Division, a classroom is then set aside and a schedule established.

Since the San Mateo County trade and contractor representatives carry out their journeyman training responsibilities in this manner, JCC's effective operation requires a free flow of communication among the committee members themselves and between them and the College of San Mateo. But to carry out these functions both the union members and the contractors must continually evaluate the training needs of the electricians.

In actual practice, the responsibility for a continuous appraisal of journeyman training needs rests heavily upon the Business Agent of

IBEW Local 617 and on the Executive Secretary of the San Mateo Chapter of the NECA. Without the dedicated effort of these already overburdened men, little in the way of planning for continuous training of journeymen in San Mateo would exist. The question of how to assign the responsibility for journeyman training to a committee whose primary responsibility is contract negotiation warrants examination; a somewhat more systematic appraisal of training needs might more logically fall under the aegis of the College of San Mateo. For the purpose of this study, the SRI research team undertook to perform that function.

While this appraisal of need was not the primary focus of the present study, the seriousness of the problem is evident. The effectiveness of any training program depends greatly upon a thorough knowledge of what the trainee's skill and knowledge requirements are:

> Unless this information is available, trainees are likely to be given too much training on some points, not enough on others, and inappropriate instruction on still others. Whether or not information on job analysis is used in planning training, the training is likely to get out of date unless constant effort is made to modify the training course to correspond with training on the job.[13]

The Bureau of Apprenticeship Training survey noted the same shortcoming in Joint Apprenticeship Committees nationally. They discovered that "about a quarter of the standards of local JAC's had not been revised during the past five years. Thirteen percent of the JAC's were operating under standards that had been developed prior to 1950." This tendency of standards to become rigid, together with the fact that only 40 percent of the national JAC's sponsor journeyman training programs, suggests that the JAC's need to exert greater effort in developing and sponsoring up-to-date journeyman training programs.

# Chapter 3

# THE JOURNEYMAN ELECTRICIAN IN SAN MATEO COUNTY

## Experience and Background

The average journeyman electrician in San Mateo County is 40 years old; of this group 25 percent are under age 32 and another 25 percent over age 48. The range of experience as a journeyman shows a similar spread, with 13 years as the average but with 25 percent having less than 5 years and another 25 percent having more than 20 years of experience.

Of all the journeymen surveyed for this study, 75 percent are high school graduates and approximately 64 percent are graduates of apprentice training courses. Almost half of the graduate apprentices completed their training in 1950 or earlier, so that because of the changes in the journeyman's job, it is apparent that those who graduated from apprentice programs some 12 or more years ago would probably need to review the fundamentals of the electrical construction trade before attempting more advanced study.

This diversity of backgrounds and experience suggests that any voluntary training program designed for the journeyman electrician must be geared in such a way as to permit the student (1) to spend his time on those areas of study in which he is less informed and (2) to capitalize upon that particular experience which enables him to move more rapidly through the program.

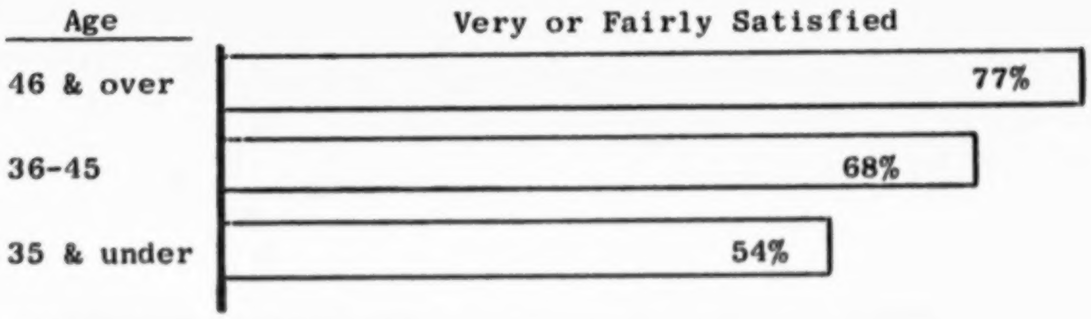
## Attitudes toward Voluntary Training Programs

More than half of the journeymen responding to the survey had enrolled in one or more adult education courses within the last five years. Of these, 55 percent (80 journeymen) registered for two or more job-related courses during this time, and 17 percent participated in two or more non-job-related courses.

Almost a third of the enrolled group, however, never completed any of the courses they started. When asked why, 47 percent of the enrollees claimed that too much material was presented in too short a time, 46 percent said that the course was not practical enough, and 31 percent felt that the course was "over their heads." Asked how the other journeymen feel about voluntary training programs, 19 percent of the total group said that they seemed to like them very much, 49 percent felt that they liked them fairly well, and 24 percent felt that the other journeymen did not like them too well. All in all, over 50 percent of the men felt satisfied with the training they had had for their present job. Older workers tended to be more satisfied than younger workers, as shown in Figure 7.

FIGURE 7

COMPARISON OF OLDER AND YOUNGER WORKERS
ON SATISFACTION WITH TRAINING FOR
PRESENT JOB
(N = 245)

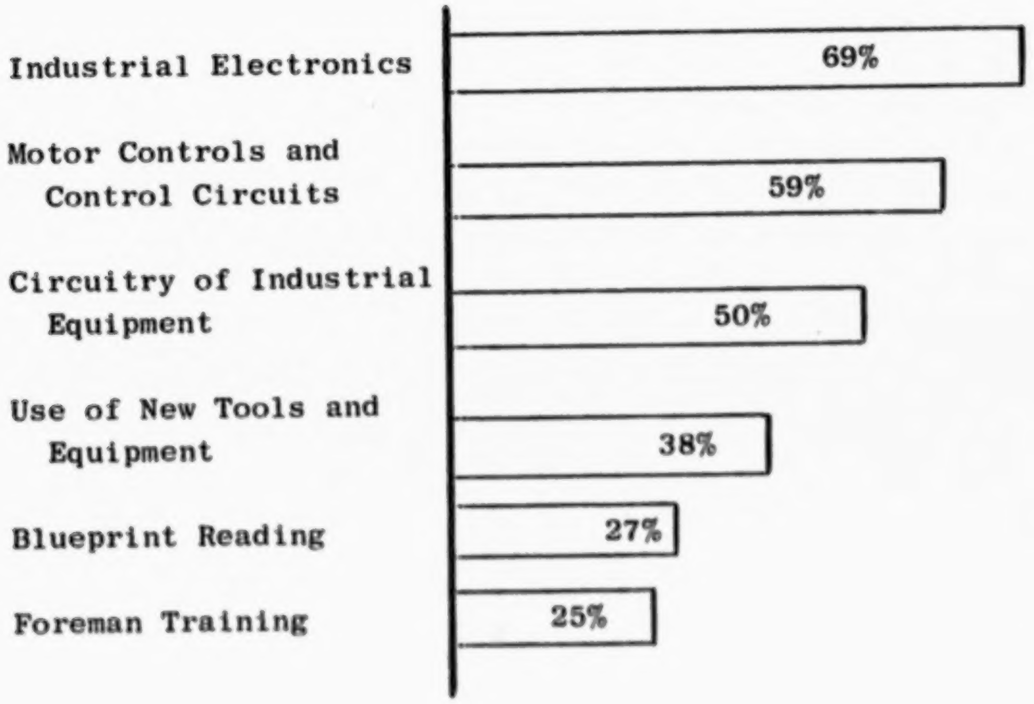


Difference significant at or beyond the .01 level.

Of those surveyed, when asked what types of courses they would like to enroll in (see Figure 8), 69 percent named industrial electronics, 59 percent preferred motor controls and control circuits, and 50 percent chose circuitry of industrial equipment. Most journeymen looked to other sources than training programs for knowledge about their jobs as shown in Figure 9.

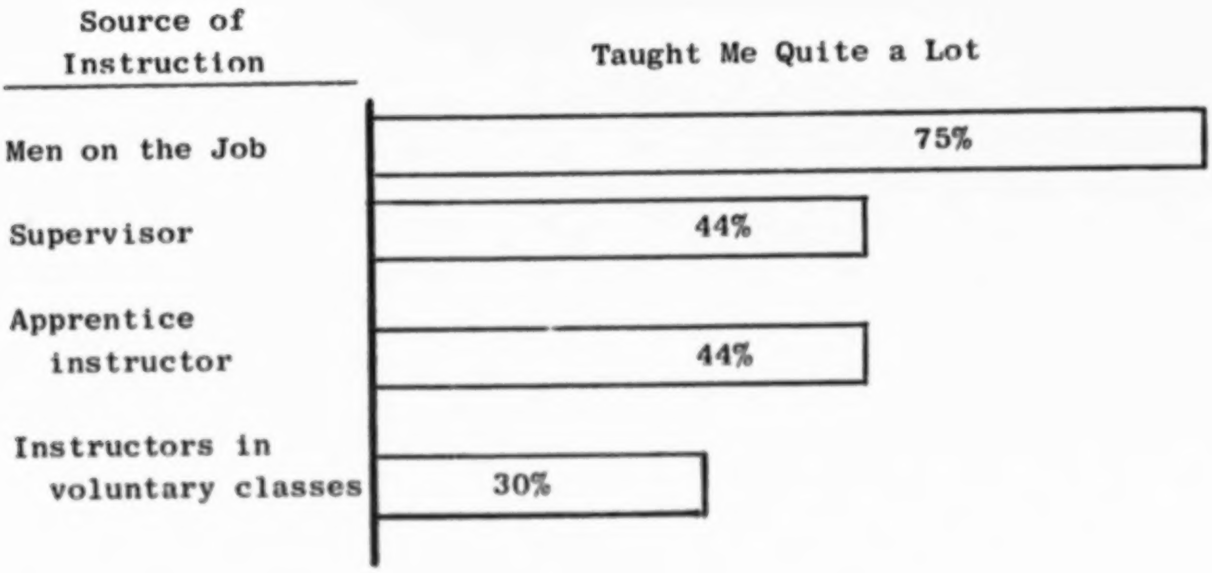
## FIGURE 8

### TYPES OF COURSES JOURNEYMEN WOULD ENROLL IN IF OFFERED
(N - 252)



## FIGURE 9

### DEGREE OF PERCEIVED LEARNING FROM VARIOUS SOURCES OF INSTRUCTION
(N = 252)



Little insight into what motivates a journeyman to enroll in a training program is obtained from the analysis of this data. Chapter 6 presents a comparison of the questionnaire responses of those who later enrolled in the experimental program with the responses of those who did not enroll. The analysis helps to identify those needs or attitudes which give rise to an interest in training, as against those factors which do not.

The present analysis establishes that slightly less than 50 percent of the journeymen had not enrolled in any voluntary education program in the last five years. Of those who did enroll, few completed their training. A large number felt that the material presented in those programs in which they had participated was not practical enough or was too difficult. The over-all attitude appeared to place the voluntary training programs among the less valued ways of learning about the job.

## Attitudes toward Present Work

When asked what things they considered to be important to themselves on the job, 94 percent of the journeymen said they wanted a job that offers a good chance to turn out quality work. "Interesting" work proved to be a close second. Seventy-five percent of the respondents said they wanted an opportunity to move up to a higher skill level, and only 12 percent sought a job that "didn't require them to work too hard." Thus, among those job factors which appear to be important to the journeyman--a chance to turn out quality work, a chance to do interesting work, and a chance to move up to a higher skill level--the fact that most can be realized through participation in training programs goes unrecognized.

## Career Aspirations

Most of the journeymen indicated an interest in moving up to a higher skill level, but few wished to leave the ranks of journeymen. When asked what they hoped to be doing 5 years from now, 26 percent said that they hoped to continue working in their present classification as journeymen, 46 percent hoped to be working in a different classification, but as journeymen, and none wanted to work at other jobs in the construction trade. Sixteen percent did have aspirations of becoming electrical contractors.

When asked to rate their over-all background and qualifications for handling current job assignments, 70 percent of the journeymen rated their own ability as above average. Job satisfaction, particularly among the older workers, was high: 82 percent of the journeymen responded that they were very or fairly well satisfied with their present jobs.

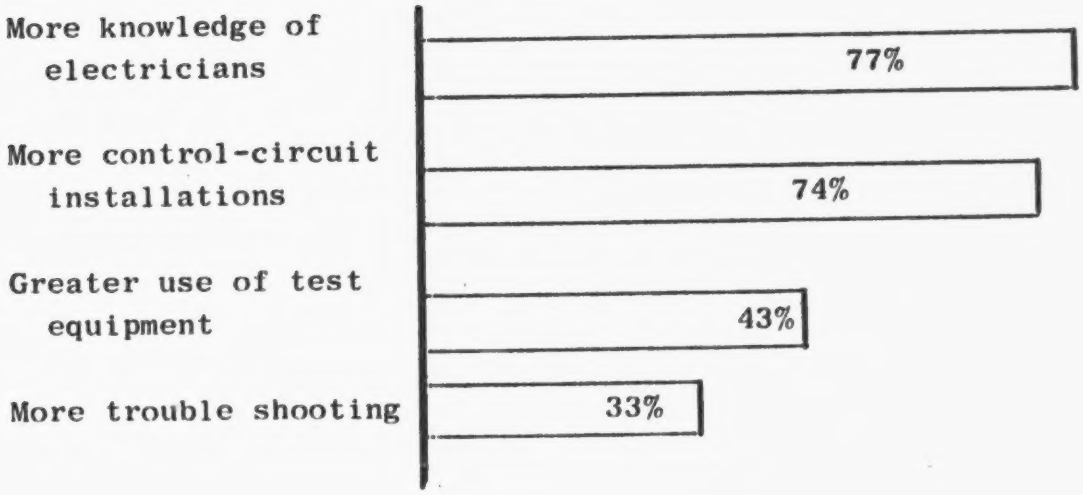
The over-all career perspective and high job satisfaction reflect a desire to stay within the occupation of electrician. These findings were supported by those of the Phase I study. The over-all pattern was one of considerable occupational stability.

## Expectations of Change

Employment in the construction industry in San Mateo County has been very steady for the past ten years. Few journeymen electricians have suffered layoffs or cutbacks in wages. Apparently, the future looks equally bright, as reflected in their response to the question, "Taking all things into consideration, would you say your future as a journeyman in San Mateo County looks better or worse than a few years ago?" Seventy-one percent of the journeymen responded that their future looks better or somewhat better than a few years ago. Most expected some or many changes to occur in their line of work within the next five years. The types of changes expected, as shown in Figure 10, are discussed at greater length in Chapter 4.

FIGURE 10

JOB CHANGES EXPECTED BY JOURNEYMEN
IN NEXT 5 YEARS
(N = 252)



Most of the journeymen saw future changes as having rather general effects on their work. Data from the Phase I interviews revealed that they were well aware of the new types of electronic equipment being installed in the more modern factory and commercial buildings, but when pressed to state specific effects of these changes on themselves, the men could not do so. However, IBEW's effort to communicate the need for training in electronics has had some effect. In the preliminary interviews, several union members specifically mentioned the potential impact of automation as their principal reason for enrolling in earlier courses they had taken.

Comments

Because of the diversity of background and experience of the trainees, a journeyman training program must offer each participant ample opportunity to explore in depth the information to be learned, based upon his own ability, and at his own rate. Absence from the educational scene for 12 years or more will probably necessitate that a number of journeymen review the fundamentals of electricity before qualifying for more advanced study.

Most journeymen are interested in performing quality work, and seek out interesting, challenging assignments. Some may not be aware of the value of formal training in obtaining these objectives.

In selecting course materials that relate to specific job problems, the journeyman is likely to apply the pragmatic criteria of usefulness and comprehensibility to a course of study. Their comments concerning previous courses underscore the significance of keeping the information to be learned on a simple and straightforward basis. Permitting this type of student to work with carefully programed instructional materials should be an advantage. Those with previous records of disinterest or failure will also need encouragement and careful handling if an interest in training is to be rekindled.

While job security has been high during the previous decade, most of the journeymen anticipate "some" to "many" changes in the next five years. Older workers tend to be more satisfied with their training for their present work than younger workers. They would be, therefore, less likely to feel motivated to take part in a training program. Since it is this older group who will require an increasing amount of training as time passes, the problem of convincing them of this need becomes more difficult.

## Chapter 4

# JOB ANALYSIS AND DEVELOPMENT OF COURSE OUTLINE

### The Job

Construction electricians lay out, assemble, install, and test electrical fixtures, apparatus, and wiring used in electrical systems in construction projects, following the blueprints and specifications provided by the architect and electrical engineer. These systems provide heat, light, power, air conditioning, and refrigeration in a wide variety of structures. The electricians also install and connect electrical machinery, equipment, controls, many types of switches, circuit breakers, conduits, and other electrical components. On occasion, the electrician is required to split an incoming electrical service into several circuits without the guidance of electrical drawings, while protecting such circuits by fuses or circuit breakers of the proper rating to prevent over-heating or malfunction. The construction electrician must understand and follow the National Electrical Code regulations as well as fulfill state, county, and municipal regulations.[10]

The large increase in construction activity and the increased demand for electrical installations by commerce, industry, and private residences are the two major causes of the growth of the electrical trade. New appliances in the home demand more electrical outlets, switches, and wiring. In addition, the widespread use of electronic data processing equipment and of electrical control devices demand complicated electrical systems, especially in the newer commercial and industrial buildings. These changes in technology and materials have led to a decrease in physical effort, but journeymen must now be highly skilled as well as flexible in their capabilities.

The recent apprentice graduate is recognized as being more qualified than earlier graduates of the apprentice program. According to a study of a sample group of former apprentices who had recently completed training,[11] both the course of training and the type of man selected for apprenticeship have been upgraded to meet the demands of the job. Of those who had graduated only six years earlier from the electrical apprentice program 21 percent were presently employed as foremen.

## Steps in the Task Analysis

The success of any training program rests to a great extent upon the care taken in specifying the goals of the program, i.e., the knowledge and skills expected of the trainee at the conclusion of the course. In this study, the development and experimental evaluation of the journeyman training program and the determination of training needs followed the lines shown in Figure 11. Analysis of the task, specification of training objectives, and development and selection of course materials are described in this chapter. Evaluation of training effectiveness is discussed in Chapter 6.

After reviewing the literature on the journeyman electrician and his job, a member of the SRI research team conferred with a local representative of the IBEW and of the contractors' association. They, in turn, scheduled a series of interviews with San Mateo County electricians and contractors. Out of 35 volunteers, 12 journeymen were selected by the Business Agent of IBEW Local 617 for interviewing as representative of various backgrounds, job assignments, and experience with training programs.

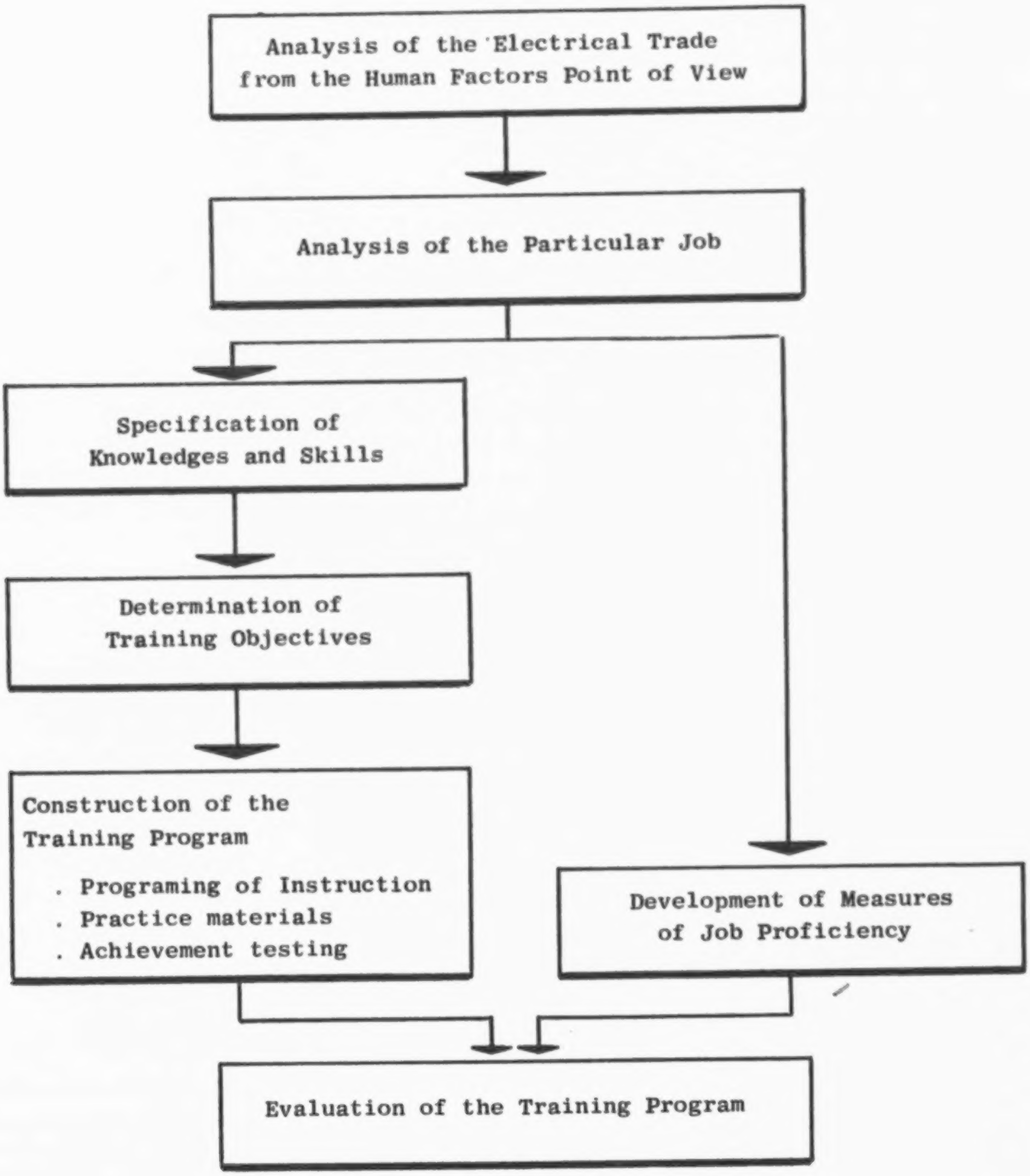
At each interview, SRI sought information on what interest the man had in further training, what knowledge or gain he expected from participation in a training program, his personal and job-related goals, an evaluation of his responsibilities, and the changes he had seen in his own job within the last five years.[1]

In addition, five contractors representing a range of firms involved in residential, business, and industrial construction were selected for interview. In these interviews, an effort was made to determine what each of the men expected of the proposed training program. Examples were solicited of typical problems encountered by the contractors as a result of inadequately trained employees.

Background material was also obtained by SRI from interviews with a local building inspector and with representatives of Stanford University's linear accelerator project. (This is a major building program involving a large number of journeymen, to be carried out within San Mateo County over the next five years.)

FIGURE 11

STEPS IN THE DEVELOPMENT OF A JOURNEYMAN TRAINING PROGRAM


Analysis of the Electrical Trade from the Human Factors Point of View
Analysis of the Particular Job
Specification of Knowledges and Skills
Determination of Training Objectives
Construction of the Training Program
. Programing of Instruction
. Practice materials
. Achievement testing
Development of Measures of Job Proficiency
Evaluation of the Training Program

From these initial interviews, an attitude questionnaire was prepared and pre-tested. It was then revised and mailed to the local union members.

## Specification of Knowledge and Skill Requirements

Analysis of the interview data established that certain knowledge and skills are critical to successful performance as a journeyman electrician:

1. A firm grasp of the fundamentals of electric circuit theory, both AC and DC
2. An understanding of simple schematic diagrams and an ability to make simple electrical calculations based on such diagrams
3. A thorough knowledge of symbols and conventions used in electric wiring and schematic diagrams
4. An ability to accurately read an electrical construction blueprint and interpret it in terms of the basic schematic diagrams to which it corresponds
5. An ability to hook up simple electric circuits, such as motor control, relay, and test equipment circuits, with or without the use of electrical wiring diagrams
6. An ability to use electrical test equipment and to interpret the readings of the instruments
7. An ability to "troubleshoot" lighting, motor, control, and electronic circuits, such as those found in numerically controlled machine tools
8. Familiarity with the more common provisions of, and tables provided by, the National Electrical Code and its local variations
9. A knowledge of the safety factors involved in working on industrial, commercial, and residential electrical and electronic circuits
10. Familiarity with the elements of vacuum tube and transistor circuitry

From this list of specific job needs, the research team recognized that a one-semester course could not adequately cover all ten subjects. It was recommended that the training course begin with a review of the fundamentals of electric circuit theory, and, where possible, incorporate information and practice dealing with the other areas.

This decision was supported by the observation that electrical contractors require two quite different types of journeymen. The first group should be specialists in electronic circuitry, with a built-in capability for trouble-shooting control circuits and making complicated installations. Each contractor needs to develop two to four such journeymen, depending upon the size of his shop.

The second (larger) group is not likely to require a particularly thorough and specialized knowledge of electronic circuitry. These journeymen should have a working knowledge of AC and DC parallel and series circuits, and of basic electronics. They must also possess an ability to understand and use simple mathematical tools, experience in using the national and county code books and tables, and a well developed ability to read blueprints and understand simple circuits.

Thus, an introductory training program that properly reviewed the fundamentals of electricity and provided an opportunity to rebuild some of the basic skills of journeymen would serve as: (1) a screening program for those who might become electronic specialists and are motivated toward more advanced study and (2) as a refresher course for those who are not qualified or interested in going more deeply into the field of electronics.

### Journeyman Expectations from Training

Findings from the mailed questionnaire survey reported in Chapter 2 provide additional information on the types of problems that the journeyman expects to encounter on the job. Asked to comment on what technical changes they expected to see in the next 5 years, and how this would affect them, only 3.7 percent foresaw no changes; 74 percent thought there would be more control circuit installations; 77 percent of the respondents felt that an increased knowledge of electronics would be required; and 43 percent felt there would be a greater need for training in the use of test equipment.

When asked what types of changes they had seen within the past 5 years, 75 percent responded that they had seen many new types of equipment come in, 56 percent had seen a greater variety of work, and 35 percent recognized an increased emphasis on automation.

Asked to comment on what types of problems they might run up against on the job, problems that a training program could help to solve, 35 percent of the men stated that they wanted help on such problems as those of industrial and motor controls. Fourteen percent wanted help in design and layout problems, with particular emphasis on reading blueprints and schematic drawings and on interpreting the electrical code. Other men wanted to know more about selected aspects of electronics; they wanted to become familiar with new electronic tools and measuring devices and wanted more knowledge of how to install and maintain electronic equipment (see Appendix B).

Seven percent of the journeymen reported a need for training in human relations. The extent to which an electrician can work successfully with plumbers, pipefitters, and sheetmetal workers is frequently an important factor in determining the cost and time required for electrical installations. These interests were reflected in the types of courses in which the men said they would like to enroll.

## Course Objectives

The objectives established by the SRI team were that the training program assist the journeyman electrician in the following ways:

1. Help him to improve his job performance,

2. Help him to enlarge the scope of work which he is qualified to perform, and

3. Enable him to do electrical work involving newly developed technology or that currently under development.

In addition to the achievement of these broad instructional goals, a successful journeyman training program would also recognize certain psychological factors relating to the training process. It would:

1. Provide an opportunity for each trainee to progress at his own rate, based upon his unique ability and background

2. Permit each trainee to conceal any lack of information or skill from other members of the class

3. Simplify the subject matter so that trainees could absorb the information to be learned without undue effort or frustration

4. Allow those who were already skilled, or were capable of progressing more rapidly through the subject matter, to do so

From the perspective of the electrical contractor, the course should offer a review, for the majority of journeymen who probably would not go on to become electronic specialists but who needed to keep their working knowledge of the electrical field sufficiently up to date to perform their responsibilities efficiently. For those who were capable, and motivated to go further, the course should also serve as the first step in a series of training programs. The contractor also expects the training program to improve skill in the use of test equipment and in making installations as well as to increase knowledge of the fundamentals of electricity.

## Development of the Course Outline

Following the analysis of the journeyman's job, specification of the knowledge and skill required, and the determination of the training objectives, an ad hoc committee was formed for the purpose of reviewing prospective course outlines. This committee was made up of one representative of SRI, an electrical engineer[*] serving as consultant to SRI, four prospective instructors,[**] a Supervisor of Technical Education at the Bureau of Industrial Education, the Technical Director of Adult Education for the College of San Mateo, and the Business Agent for IBEW Local 617.

In the selection of course materials, the committee was guided by the need to provide both instruction in theory and the practical applications of this theory to the requirements of the job. In considering the problem of transfer of training, the committee felt that individual laboratory exercises, with emphasis on student performance rather than on instructor demonstration, would serve as a valuable link between classroom and job.

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[*] An able and experienced electrical engineer brought to the committee a wealth of technical knowledge as well as programing experience from previous work with U.S. Industries in the development of their first-year course in electronics.

[**] Two were journeyman electricians from San Mateo County and two were instructors from the Naval Training Center at Treasure Island.

With these considerations in mind, the committee evaluated existing courses on industrial electronics. The California State Department of Education program[14] specifically designed for apprentices; the U.S. Department of Health, Education and Welfare two-year post-high school curriculum in electrical technology;[15] a Philco electronic program;[16] the IBEW industrial electronics course;[17] and one or two other junior college courses were reviewed.

In addition, the committee sought a course which was already in programed form.* A course originally programed for the Air Force Basic Electronics Technical School at Keesler Air Force Base[12] was found to meet most of the requirements. The committee felt that some rearrangement of the material would be advisable and that two of the subject areas might better be revised completely. Figure 12 presents the completed course outline. (See Volume II for a complete listing of the materials developed for the course.)

Lesson 1, as adapted and microfilmed from the Hughes-Pipe Tutor Test,[18] offered a more succinct version of the material on electron theory. Approximately 100 frames took the place of 400 frames used in the original Air Force program. Lesson 2, entitled "Powers of Ten; Exponents; and Resistance Calculations," was completely reprogramed by the SRI research team, at which time it was organized to present those mathematical principles which were judged essential to electricians.[19] The lesson did not attempt any extensive review of general mathematics, however, on the assumption that this would be of limited usefulness as well as discouraging to many men whose background in mathematics was limited. (Note that in the title of the lesson no reference is made to mathematics or algebra.)

For those interested in the problems of writing instructional programs, the following quotation is printed in its entirety because of its clarity of statement and simplicity of form:

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* Programed form refers to instructional material designed for use on a programed instructional device such as a teaching machine or a programed textbook. The principles of programing are discussed later in this chapter.

1. Write down a description of your audience in terms of the educational levels of its members, their prerequisite skills, and motivation;

2. Write down your objectives in behavioral terms (in other words, say what the journeyman will be doing when he demonstrates that he has reached the level of performance expected);

3. Draw up a list of headings and sub-headings to show the content of the program;

4. Organize this list into the progression which seems best to obtain the objectives set out in Step 2;

5. Write the prime path of the program (the "right answer" pages, that is);

6. Have this part of the program edited, and preferably have it looked over by an expert (even if your writer is an expert) for evaluation of its technical merit;

7. Write the branching sequences;

8. Have them edited;

9. Try out your draft on some typical members of your proposed audience. Then make any changes that seem to be needed in the program if it is to get students to the expected criterion level.[20]

Appendix C gives a more complete description of the objectives and procedure followed in the reprograming effort for Session 3.

Sessions 4 through 7 were taken as originally programed, but with some repositioning of sections where the committee decided a more suitable arrangement was necessary. Occasional corrective frames or new transitional frames were introduced at the suggestion of the curriculum consultant. The lesson on Magnetism was moved to the second half of the course and, therefore, was not part of the experiment. In all, the 2,800 microfilm images were cut to approximately 1,100 frames for use in the first half of the semester.

## Figure 12

## COURSE OUTLINE: INDUSTRIAL ELECTRONICS

| | Session | |
|---|---|---|
| SRI Experimental Program | 1 | Pre-tests, Orientation, Basic Electron Theory |
| | 2 | Basic Electron Theory (continued) |
| | 3 | Powers of 10; Exponents, Resistance Calculations |
| | 4 | Fundamentals of Electric Circuits |
| | 5 | Fundamentals of Electric Circuits (concluded) |
| | 6 | Power; Kirchhoff's Laws |
| | 7 | Series Circuit Analysis |
| | 8 | Parallel and Series-parallel Circuit Analysis |
| | 9 | Mid-term Examination |
| | 10 | Magnetism and Electromagnetism |
| | 11 | Elements of Alternating Current |
| | 12 | The Sine Wave |
| | 13 | Effective Voltage and Effective Current |
| | 14 | Three-phase Circuits |
| | 15 | The Transformer |
| | 16 | Rectification of an AC Wave |
| | 17 | Diodes--Vacuum Tube and Semiconductor |
| | 18 | Final Examination |

At an average rate of 60 to 120 frames per hour, the students were expected to complete this portion of the course during the first 8 weeks. The slower students were permitted to attend one or two make-up sessions, while the faster students were given extra lessons at various intervals to keep them from moving too far ahead of the others. The faster students also received additional material on the subject of "power loss" at the end of the 5th lesson and had an opportunity to try out problems on series and parallel circuits at the end of the 7th lesson.

Written and oral review material, review tests, hand-out materials, and homework assignments were prepared by the SRI research group and distributed by the instructors during the first 7 weeks of training. The choice of textbooks and lab demonstration equipment was based on the recommendations of two experienced instructors who had worked with such texts in the past. (A list of such texts appears in Volume II.) These texts were provided free for the student's use during the term. After the mid-term examination the course continued in its normal form as part of the College of San Mateo program.

Duplicate sets of laboratory and demonstration equipment were provided for the two classrooms where the training courses were held. Individual tool kits and materials required for the laboratory exercises were provided for each student's use, and arrangements were made to provide each pair of students with the use of a multimeter. In each classroom, a set of Philco electronic demonstration panels was installed for the primary purpose of allowing those students who had progressed more rapidly through the course materials to try out basic experiments and demonstrations on the board. (Volume II gives a listing of laboratory and demonstration equipment purchased for use in the course.)

## Programing Costs

Programed learning is expensive. Commercially available programs are relatively economical but do not always fit the requirements of the trainee. A tailor-made program, prepared by a programing firm, may require as much as 40 to 50 man-hours of effort for each hour of instruction, and at an estimated preparation cost of $800 to $1,200. In-house preparation of programs may cost from $6 to $10 per frame. For the preparation of frames on the outside, costs may range from $14 upward if the program is to remain the exclusive property of the purchasing company.[21] Shorter programs (under 1,500 frames) are proportionately more expensive because the start-costs (task analysis, etc.) are the same.

In revising the U.S.I. TutorFilm, the following estimated costs were incurred by the research team:

1. Revision of Reels 1 and 2 of TutorFilm Program "First Year Electronics"

| | |
|---|---|
| $1,060 | Consultant fees |
| 35 | Typing (on animation paper) |
| 70 | Splicing and re-filming |
| $1,165 | |

2. Programing of Lesson 2 (100 frames):

| | |
|---|---|
| $ 200 | Technical writer (40 hrs @ $5/hr) |
| 282 | Programer (49 hrs @ $5.75/hr) |
| 90 | Consultant (6 hrs @ $15/hr) |
| 450 | Typing (special format) |
| 50 | Pre-test (2 journeyman electricians) (Total of 10 hrs @ $5/hr) |
| 130 | Microfilming |
| $1,202 | |

The programing cost per frame ($12 under #2 above) compares favorably with the experience of industrial concerns who have undertaken to program their own course materials. An atypical cost incurred by the research team was that of pre-testing the program on two journeymen at their usual rate of pay. This was offset by savings resulting from the assistance of U.S. Industry personnel in the "scrambling" of the frames once they had been prepared.

Experimental programs* in industry have, on the average, realized a saving in time of from 33 percent to 50 percent over conventional training courses. The present study cut by approximately 50 percent the traditional length of time of a course in Direct Current Theory, although the time expended was by no means accurately determined since make-up sessions and extra lessons were introduced to meet individual student requirements.

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* For a well designed and fully documented study of the reduction in training time realized through the use of programed instruction, see Reference 22.

Comparison of the costs of a conventional program (on Direct Current Theory, for example) with the estimated costs of a programed course (presented by means of teaching machines) should be based upon the cost per man per unit of instruction. An 18-week or 54-hour course in which 26 men are taught in one class with one instructor, who is compensated at the rate of $6 per hour, costs $13 per man. A comparable course, taught in half the time through the use of programed instruction (9 weeks) but requiring two classes of 13 men each, would have cost $21 per man, based upon the purchase of 13 AutoTutor machines (at $1,000 per machine amortized over 5 years), the purchase of 13 TutorFilms (at $125 per film amortized over two years), and the salaries of two instructors (at $5 per hour for each instructor) who would serve as class monitors. The cost per man could be considerably reduced if the cost of the machine could be prorated over a larger student body. Still further savings could be realized by substituting programed textbooks for the machines and films, but possibly at the loss of certain advantages. (Chapter 5 examines in more detail the advantages and disadvantages of programed texts when compared with teaching machines in the instruction of adults.) The use of a programed text, at $5 per text, together with a monitor* would bring the cost to $10 per student.

While the cost of the course cannot be determined with a high degree of accuracy, adapting a commercially available program to the needs of the journeymen in the experimental program was approximately $3.50 per frame. This should be contrasted with the $12 per frame cost of the inhouse programing of a single lesson.

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* Only one monitor would be required since a sufficient number of texts could be obtained for a class of 26 students.

## Chapter 5

# THE INSTRUCTOR AND PROGRAMED INSTRUCTION

One of the major obstacles to the development of a sufficient number of journeyman training programs is a shortage of qualified instructors. To provide adequate faculty for the adult education programs of California's 68 junior colleges requires a major recruitment effort. Because of the caliber of instructors required for many of the more technical courses and because of restrictions on faculty salary levels, many junior colleges are competing for qualified instructors. The problem becomes even more acute in the electronics area because of the high-pay industrial opportunities available to engineers and electronic technicians who thus do not seek a second income. This chapter describes the effort to find qualified instructors for the experimental training program, the procedure for their orientation to and familiarization with the training program, and some suggestions for solutions to the instructor shortage problem.

## Instructor Prerequisites

The interview and questionnaire data indicated that many of the journeymen's prior experiences with training programs were to some extent unsatisfactory because of the quality of instruction. Overqualified instructors were as troublesome as underqualified instructors. Because of his inability to bring himself "down" to the level of the journeymen, the overqualified instructor was sometimes thought to be "too theoretical," and not enough oriented toward the journeyman's on-the-job needs. These observations led to certain requirements, or criteria, for the selection of instructors:

1. The instructor selected for the retraining course should have a thorough knowledge of the journeyman's job and responsibilities, in addition to being very competent in his field.

2. He should be able to gear his presentation to these job needs in words which could be understood by the journeyman.

3. He should be aware of the problems of educating adults and should have had experience in this field.

4. He should have had experience in applying the subject matter of the course to journeyman-type problems.

The College of San Mateo and IBEW Local 617 guided the research team's search for likely instructor candidates of whom four were required for the full semester, two to serve as monitors in the programed modes of instruction and two to carry out the conventional instructor role in the classes featuring live instruction. The principal function of the monitors would be to start the journeymen working on the programed instructional devices (the teaching machines), to answer individual questions which arose during the class period, and to administer the laboratory problems or exercises during the latter portion of the class period. The monitors, it was decided, would not necessarily have to be trained or experienced classroom instructors, but they would have to have a thorough knowledge of the journeymen's job. They would serve as adjuncts to the automated instructional devices.

Two journeymen from the union were asked to participate in the experiment as monitors. Each had had extensive experience as a journeyman, but no experience as a classroom instructor. One was an inside wireman and had had some supervisory experience; the other had 15 years' experience as an electrical supervisor and was employed as a foreman of maintenance personnel in a steel company.

For the live instruction classes, two Navy electronics instructors were recruited from the Class "A" Electronics School at Treasure Island. One had been an instructor for two years, teaching basic electricity and electronics, transistor theory, laboratory techniques, and allied subjects; he had previously taught at junior colleges. The other, who had been at Treasure Island for four years as an instructor in electronics, physics, algebra, transistors, radar, and related fields, had also served as an electronics maintenance supervisor aboard ship. (Upon retiring from their Navy careers, both men quickly found employment as technicians in peninsula area electronic firms.)

## Orientation

For the purpose of orienting the instructors to the experimental program, each was asked to serve as an advisory member of the ad hoc committee in developing course outline and content. The two experienced instructors (from Treasure Island) were asked to contribute a number of laboratory problems to meet the course requirements and to ascertain what kind of laboratory equipment would be required. All instructors reviewed the programed material on the teaching machine so that they were fully aware of the scope and direction of the course. They then suggested outside reading assignments and supplementary course materials.

Each of the two Navy instructors was provided with a set of "right answer" frames from the program. This served as his guide in preparing his own course outline and instructional materials.

Because all four of the instructors participating in the experiment would be involved, in one way or another, with the teaching machines, all were given instruction and a practice session in operating them. Also, a representative of the California Bureau of Industrial Education explained the operation and use of the experimental audio-visual equipment (which was set up in the Union Hall for the conventional classroom mode sessions there) to the instructors who would hold those meetings. Both types of equipment are described in detail in Volume II.

Because the experimental audio-visual equipment was not made available until just before the course began, neither of the two classroom instructors became sufficiently practiced in the use of this special equipment. Also, the audio-visual equipment did not function properly (i.e., there were electrical failures). Had things gone well, some conclusions might have been drawn about the effectiveness of electrically-controlled group feedback. This was not possible.

Once the experiment was under way, the instructors met periodically with the SRI research team to critique the program and to develop instructional materials to be distributed to the students; review tests for use in each of the instructional modes were developed in this manner. Members of the SRI research team monitored the classes, and were thus able, for example, to suggest that the instructors encourage more questions, particularly in the automated modes of instruction, and to press for greater care in following the prescribed lesson plans and time schedules in the lectures.

## Instructional Techniques

The advantages of programed instruction over other modes of instruction[23] are that it:

1. Permits the student to progress at his own pace

2. Takes full account of individual differences in learning ability

3. Virtually assures improved learning because the information to be learned requires carefully pretested and logically sequenced units of information.

4. Offers the advantage, in the branching program (as contrasted with a linear or Skinnerian approach) of permitting the student, who already has a particular skill or knowledge in one facet of the subject, to move forward more rapidly.

The criteria used in this study for the selection of self-instructional devices were:

1. The equipment should provide immediate feedback of results to the student as to the adequacy of his response list.

2. The machine should provide a record of the individual student's responses so that the instructor, if he wishes, could analyze the progress of the individual student at the end of each instructional period.

3. The device should permit audio as well as visual presentations.

In selecting the AutoTutor machine, manufactured by U.S. Industries, for use in the experimental portion of the course, all but the last criterion was met. The availability of a TutorFilm on electronics designed for use on the AutoTutor machine was also a major determining factor.

## Teaching Machines vs Programed Texts

Although previous studies[24] had demonstrated that a programed text book usually served as well as a teaching machine, the unavailability of a commercially prepared text suitable to the training of journeymen electricians made it necessary to reject this possible alternative for this study. The research team also felt that the programed text lacked certain other advantages of the machine mode. For example, the machine conceals the amount of material to be learned and eliminates the depressive effects of the student's being overwhelmed by the material he is expected to digest. Again, the appeal of employing an intrinsically interesting device, with some gadgetry, is not to be overlooked, especially for journeymen electricians.

In the branching form, the programed text book cannot force the student, particularly the adult student, to follow a prescribed sequence of frames even though his incorrect responses may warrant his doing so.

The machine, on the other hand, "locks in" the student; it forces him to follow a sequence prescribed by his own unique learning ability. The practice and review he needs are built into the machine program. The branching type of program usually contains a series of sub-tests every thirty or so frames. If the student misses any of these questions, the program requires him to review all or a portion of the previous lesson before he can move on to the next. It is true that the programed text book follows the same principle, but the student may choose to ignore the book's instructions to redo that section. The machine forces him to follow such instructions.

## Comments

Initially the study was designed to use experienced journeymen in combination with self-instructional procedures; it was hoped that this would result in an effective instructional program and at the same time provide the students with access to someone cognizant of their actual on-the-job needs. The research team argued that because an experienced journeyman would be more readily accepted by the trainees he would not be perceived by them as too "impractical," "unrealistic," or "theoretical." It was also hoped, initially, that journeymen having no prior experience as instructors could, in combination with programed instructional materials, meet the instructional needs of journeymen, and at the journeymen's level. If this plan proved to be successful, it could then be recommended that such an approach be tried by other junior colleges, thus opening an entirely new market for less formally trained and less experienced instructors. The anticipated recommendation could not be made, however, for the reasons described in Chapter 7.

The commitment of non-faculty instructors to their instructional roles was less than desired because of other commitments. Full-time jobs elsewhere often dictated against spending sufficient time in the preparation of course materials and presentations. The burden of record-keeping was such that the instructor felt pressed in keeping up with the administrative paper work alone. A junior college might better employ a sufficient number of full-time instructors for work at the adult education level and schedule their work just as it would for a daytime program. Such a practice would offer the added advantage of specialized training of these adult educators for work with a population which is demonstrably different from that of junior college students.

## Chapter 6

## TRAINEE MOTIVATION AND RECRUITMENT

A primary purpose of this study was to seek out new ways of motivating adult workers to take advantage of available training opportunities and to encourage them to continue their participation once enrolled. Initial enrollment in a training program can be characterized as a function of: (1) the journeyman's training needs, (2) his awareness of the opportunity, and (3) his attitudes toward training as molded by his previous experience.

Two approaches to the study of what motivates journeymen to enroll in training were employed. The first approach served as a demonstration that several well-accepted techniques of communication and persuasion are effective by substantially increasing the number of journeymen enrolled in the training program as compared with previous records of enrollment. It should be noted that success in recruitment was not compared with an appropriately matched group of journeymen recruited in other more conventional training; however, the results could be contrasted with those obtained a year previously when a similar offering had been made by the College of San Mateo as well as by San Jose City College. This chapter describes the actions taken and the results.

The second approach used the data acquired through the mailed questionnaire survey. The availability of data on backgrounds, and on attitudes toward previous training, made it possible to contrast the opinions of those who enrolled with those of the journeymen who did not enroll in the experimental program. This second approach consisted of an analysis of the motives that led up to the act of enrollment. The implications of these findings for development of a new kind of recruitment effort are discussed.

### Person-to-Person Communication in Recruitment

Increased interest in training was achieved by building on already existing lines of communications. Among the most effective of these already established communications channels was the Business Agent of the union, who had long been convinced that a sustained retraining effort was necessary if the journeymen were to maintain their job security. He was among the first advocates of an experimental training effort. At monthly union meetings and in the local union paper he seized any opportunity to urge the journeymen to take advantage of the voluntary training programs offered by the College of San Mateo.

A second, and equally important, group of communicators was the journeymen who participated in the initial interviews. The interest and enthusiasm generated at the time of their participation in the interviews was later communicated to their associates on the job. During each of the interviews, the interviewer demonstrated the AutoTutor machine. There was little selling required as the response of the interviewees was immediate and enthusiastic--an attitude subsequently reflected in their enrollment in the training program with ten of the twelve interviewees actually enrolling. These 12 journeymen, together with the two journeymen recruited as instructors, became highly credible communicators in support of the course.

A third mode of communication was the questionnaire survey conducted three months prior to the actual training program. The introductory and follow-up letters (see Volume II), together with the types of questions asked of the respondents, were found to have generated considerable interest in the proposed training. The willingness of the journeymen to expend time and effort in completing the rather lengthy questionnaire and their write-in comments were testimony to the principle that worker involvement yields positive attitudes toward a program when workers are given the opportunity to contribute to it.*

One of the major advantages of a questionnaire survey is that it provides the respondent with an opportunity to comment on what kind of training he needs. Initial interest will not be maintained, however, unless positive action is taken to provide a meaningful and well designed training program.

One week prior to the beginning of the actual training program, a meeting was called of all the journeymen in San Mateo who had indicated on their questionnaire that they would like to enroll in an industrial electronics course. Approximately 150 men attended this introductory meeting, and the President of the College of San Mateo, the Chief of the Bureau of Industrial Education, and the SRI project director spoke. (The invitational letter and the agenda of the meeting are shown in Volume II.)

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* The use of a survey questionnaire to assess the interest of fire department employees in a variety of training programs at San Jose City College also resulted in a high enrollment in a subsequent course offering.

Slides were shown summarizing the findings from the attitude survey. During the showing, the proposed course outline and its experimental design were explained. (The material presented appears in Volume II.) The AutoTutor machine and the experimental audio-visual equipment to be used in the conventional classroom were demonstrated at the close of the meeting.

A free dinner at the end of the training program was offered to those journeymen whose class had the best over-all attendance record during the semester. To highlight this competition, the men were promised that each week they would be told of their standing, relative to the other classes. How much effect this simple technique had on their initial enrollment and attendance once enrolled is difficult to estimate. It did, however, help to heighten their interest and may have had a positive effect on their ultimate attendance record. (Chapter 7 gives a more detailed statement of the attendance and absentee figures.)

The initial interest shown by the journeymen, their willingness to enroll, and their improved attendance record substantiate the effectiveness of this over-all approach. Of the 150 men who attended the orientation meeting, 96 actually enrolled, a figure four times greater than attendance records in similar courses offered previously at the College of San Mateo or at San Jose City College. Orientation before the training begins, and clarification of what is expected of the journeymen, may be a crucial step in spurring them from inactive to active training status.*

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* It cannot be denied that the "halo effect" of being a part of a significant training experiment attracts the attention and interest of those asked to participate. If such an approach is successful, the obvious question arises: Why not employ a similar technique in other training efforts?

## What Motivates Journeymen To Enroll in Training

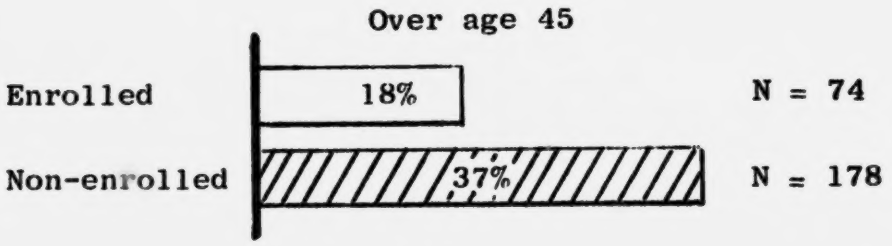
The second approach to the study of ways to improve trainee recruitment campaigns focused upon an analysis of the journeyman's motives for training. Survey data on job experience, age and previous training, career aspirations, work values, attitudes concerning job changes, and interest in training made it possible, once the names of those actually enrolled in the experimental training program were known, to contrast the attitudes and experiences of the enrolled group with the non-enrolled group. It was hoped that such an analysis would provide a better understanding of what motivates journeymen to become involved in training. Once determined, such insights should help to improve the effectiveness of subsequent recruitment campaigns.

### Background Factors and Previous Training Experience

Analysis of the attitude survey data revealed that those who enrolled in the training program were somewhat younger than the non-enrollees, were less experienced in their present job classification, and had more family responsibilities. Figures 13 through 15 illustrate the percentage distribution of these characteristics among those who enrolled and those who did not enroll. The research team speculated that those with more children tended to enroll because of their desire to get away from home at night, or because of their increased need for greater job security obtainable through training.

FIGURE 13

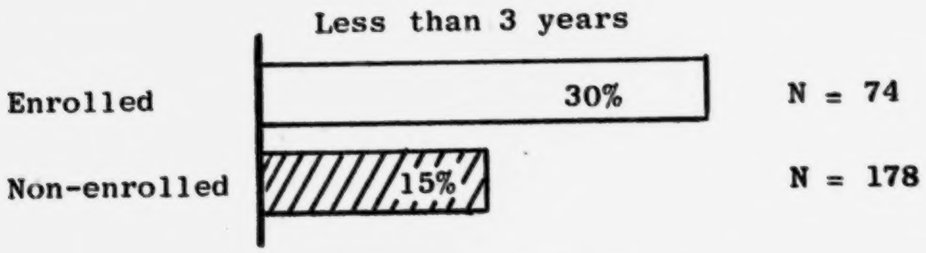
AGE DISTRIBUTION OF ENROLLED AND NON-ENROLLED JOURNEYMEN



Difference is significant at .01 level.

FIGURE 14

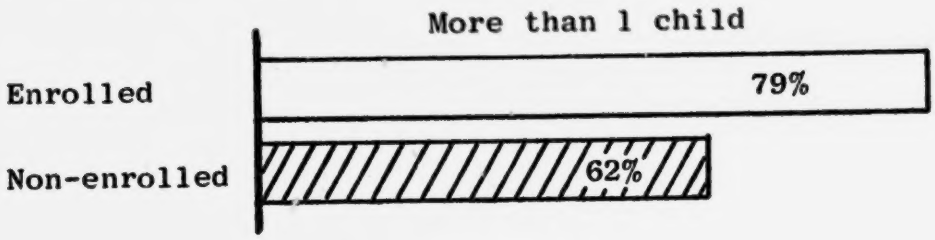
YEARS OF EXPERIENCE IN PRESENT JOB CLASSIFICATION OF ENROLLED AND NON-ENROLLED JOURNEYMEN



Difference is significant at .001 level.

FIGURE 15

NUMBER OF CHILDREN OF ENROLLED AND NON-ENROLLED JOURNEYMEN



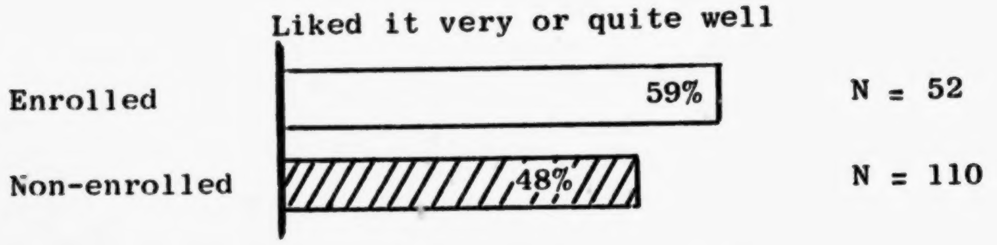
Difference is significant at .05 level.

Because of the significant difference in age between the two groups, this factor was considered in all subsequent analyses, but only the variables that differentiated between the enrolled and non-enrolled after controlling on age are reported here.

The data showed that the enrolled journeymen were more likely to have had a satisfying apprenticeship experience than the non-enrolled journeymen, as illustrated in Figure 16. When asked to comment on specific aspects of the apprenticeship program, the two groups differed in the manner shown in Figure 17, which suggests that workers with less satisfying previous training experiences hesitate to enmesh themselves in further education.

FIGURE 16

SATISFACTION OF ENROLLED AND NON-ENROLLED JOURNEYMEN WITH THEIR APPRENTICESHIP TRAINING PROGRAM*

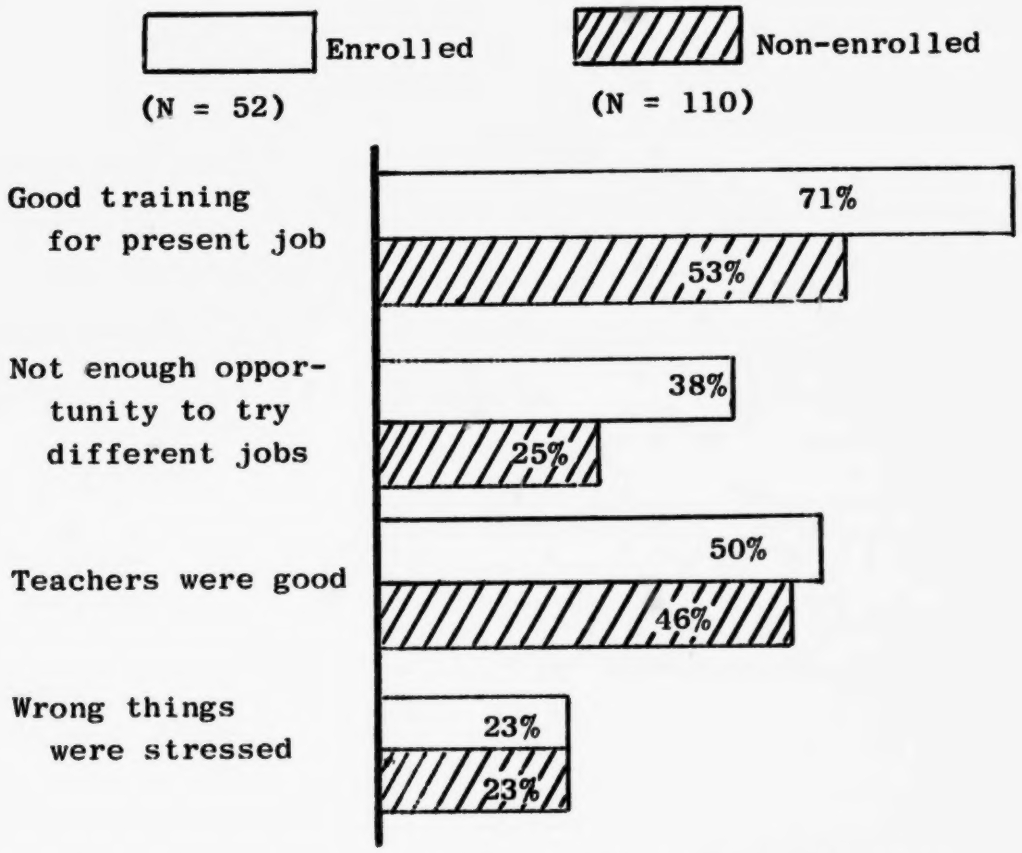


Difference is significant at .05 level.

* Only those who said they had had apprenticeship training were included in this analysis.

FIGURE 17

REACTION OF ENROLLED AND NON-ENROLLED JOURNEYMEN TO VARIOUS ASPECTS OF THEIR APPRENTICE TRAINING*

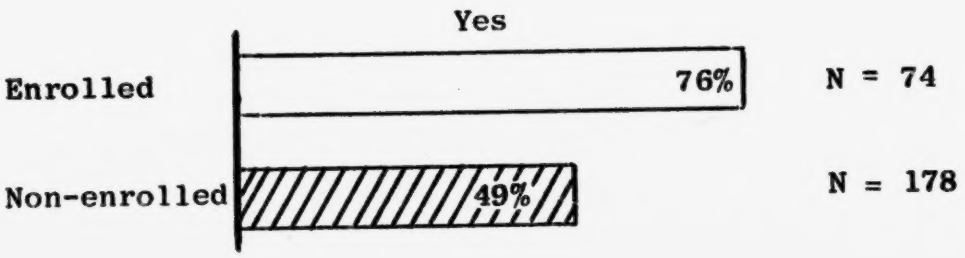


* Only those who said they had had apprenticeship training were included in this analysis.

This conclusion is also supported by the fact that 76 percent of the enrolled journeymen had taken one or more adult education classes in the last five years as against only 49 percent of the non-enrolled (see Figure 18). Completion of previous adult education classes was also higher among the enrolled journeymen, as illustrated in Figure 19. These data again indicate that a previously successful training experience did lead to a greater probability of enrollment in the present program.

FIGURE 18

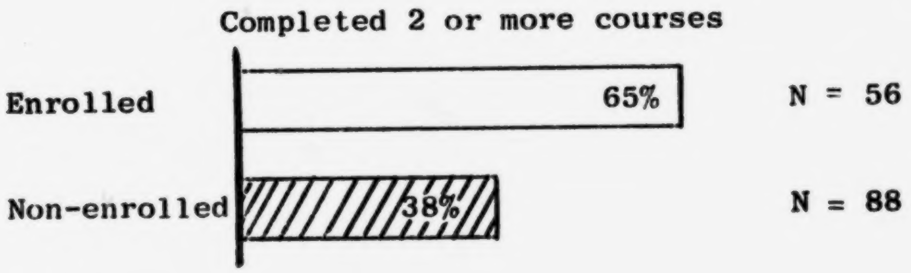
NUMBER OF ENROLLED AND NON-ENROLLED JOURNEYMEN WHO HAD TAKEN ADULT EDUCATION COURSES IN LAST FIVE YEARS



Difference is significant at .01 level.

FIGURE 19

NUMBER OF ENROLLED AND NON-ENROLLED JOURNEYMEN COMPLETING TWO OR MORE ADULT EDUCATION COURSES IN LAST FIVE YEARS



Difference is significant at .01 level.

## Attitudes Concerning Job Changes

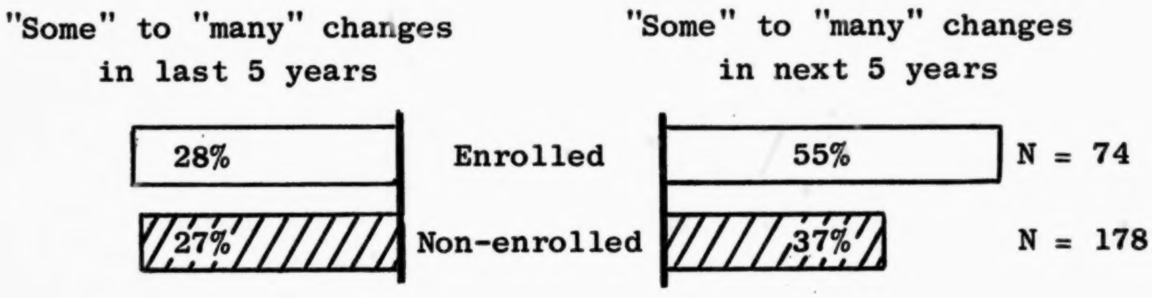
While background characteristics and previous training experience do influence a journeyman's present attitudes toward and willingness to enroll in training, such factors cannot readily be manipulated in the interest of improving a trainee recruitment effort. The fact that the enrolled journeymen had less experience in their present job classification does help to clarify one of the motives giving rise to a need for training. To base a recruitment program on this and similar background characteristics limits the campaign to a narrow segment of journeymen--those who are younger and have less job experience or more mouths to feed. One of the most difficult groups to recruit for training, for example, is the older journeymen, particularly those whose previous unsatisfactory training experience has kept them from subsequent enrollment. What points of view or arguments might be successful in bringing this hard core of reluctant trainees into the training arena suggested the area of further investigation reported below.

Figure 20 establishes that journeymen who are convinced that many changes will occur on the job in the next five years are much more likely to enroll in a supplementary training course than those who do not expect such changes. (Note, however, that there is no difference in the journeymen's perception of changes in their trade in the past five years.) When asked "What changes have you seen in the past five years? " 31 percent of the enrollees responded by checking the category "More assignments requiring background and training that I don't have." Only 19 percent of the non-enrollees responded in this way. Change has brought about a need for training on the part of the enrolled journeymen.

Coupling this observation with the distribution of responses on the question "Taking all things into consideration, would you say your future as a journeyman in San Mateo County looks better or worse than a few years ago?" indicates that those who enrolled in the training were significantly more optimistic about the future than those who did not enroll (see Figure 21). Thus it appears that journeymen who do expect changes on the job, and who expect these changes to be beneficial to themselves, are more likely to enroll in a training program than workers who do not feel this way.

## FIGURE 20

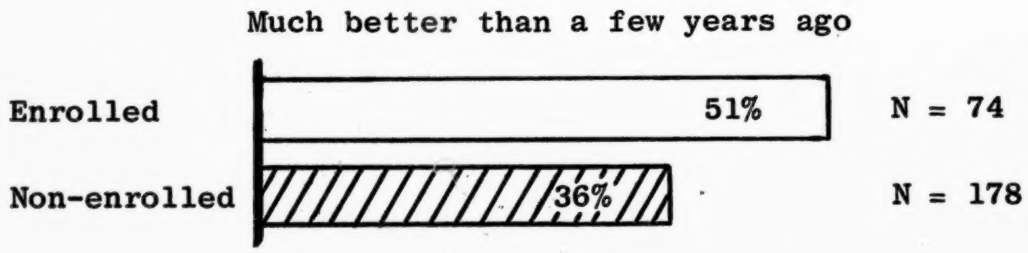
## PREVIOUS AND FUTURE EXPECTATIONS OF CHANGE AS REPORTED BY THE ENROLLED AND NON-ENROLLED JOURNEYMEN



Difference is significant at .01 level.

## FIGURE 21

## FEELINGS ABOUT THE FUTURE AS EXPRESSED BY ENROLLED AND NON-ENROLLED JOURNEYMEN

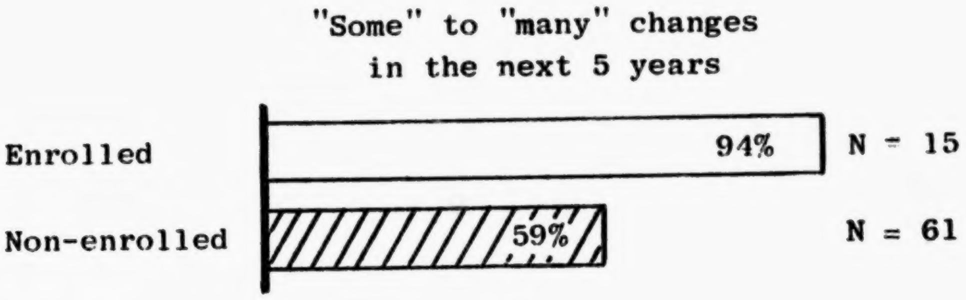


Difference is significant at .02 level.

Older workers who enrolled in the experimental program responded even more strongly on these two points as illustrated in Figures 22 and 23. This suggests that a recruitment campaign which emphasizes the rapid and possibly advantageous changes may succeed in motivating more journeymen to enroll in training, especially those in older age groups.

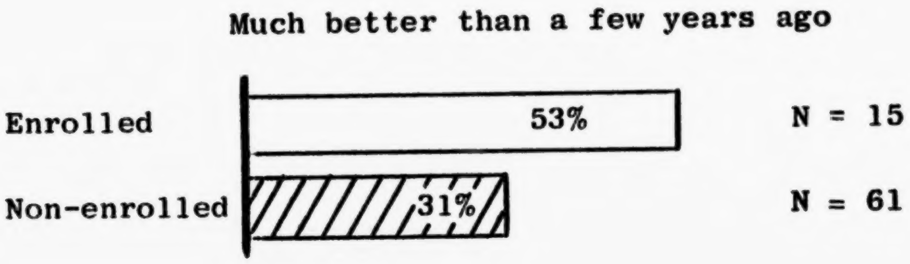
## FIGURE 22

## FUTURE CHANGES EXPECTED BY THE OLDER (OVER 45) ENROLLED AND NON-ENROLLED JOURNEYMEN



## FIGURE 23

## FEELINGS ABOUT THE FUTURE AS EXPRESSED BY THE OLDER (OVER 45) ENROLLED AND NON-ENROLLED JOURNEYMEN



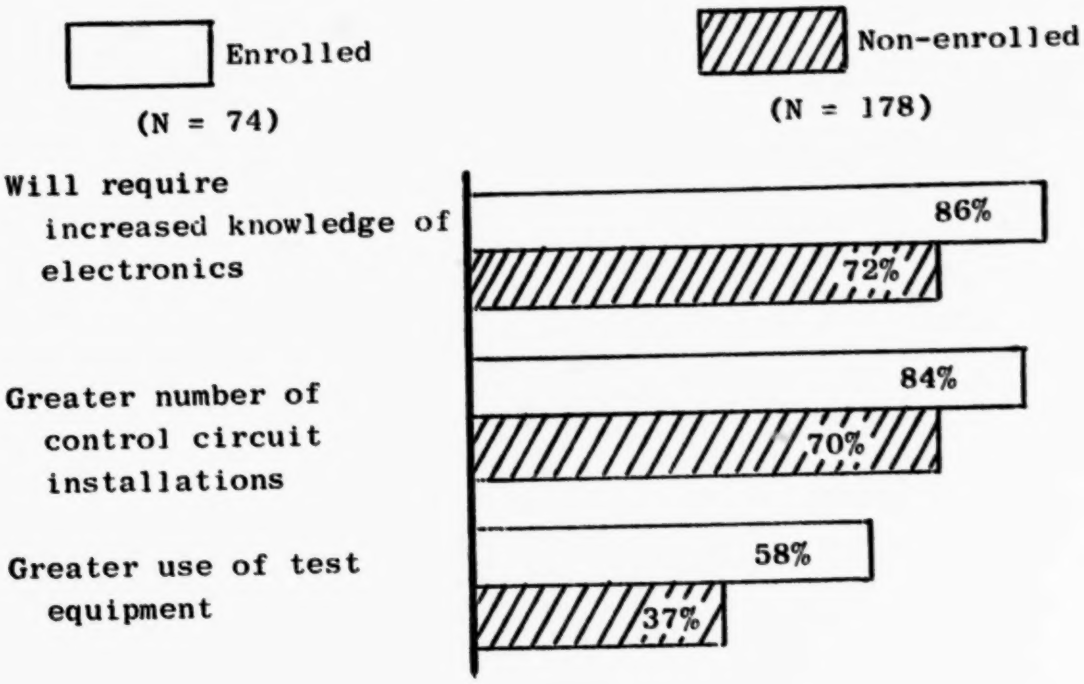
As confirmation of their expectation that changes will be occurring in greater numbers, **Figure 24** illustrates that the enrolled journeymen felt the need for increasing their knowledge of electronics. They also felt that the number of control circuit installations would be greater, and that they would need to be able to use more test equipment than in the past.

This same need for further study and training is reflected in the types of courses that the enrolled journeymen said they would be interested in taking part in if they were offered, especially when compared with the responses of the non-enrolled journeymen **(see Figure 25)**.

Only 32 percent of the enrolled journeymen responded that they were very satisfied with their present job, in contrast with 46 percent of the non-enrolled journeymen who were very satisfied. Lack of awareness of change, and complacency with one's present occupation, do operate as deterrents to interest in, and actual enrollment in, training programs.

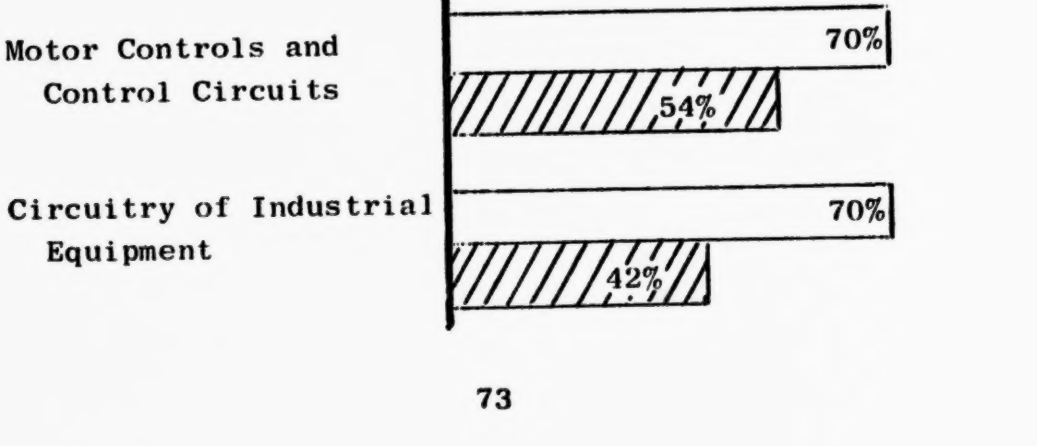
## FIGURE 24

### TYPES OF JOB CHANGES EXPECTED BY THE ENROLLED AND NON-ENROLLED JOURNEYMEN



## FIGURE 25

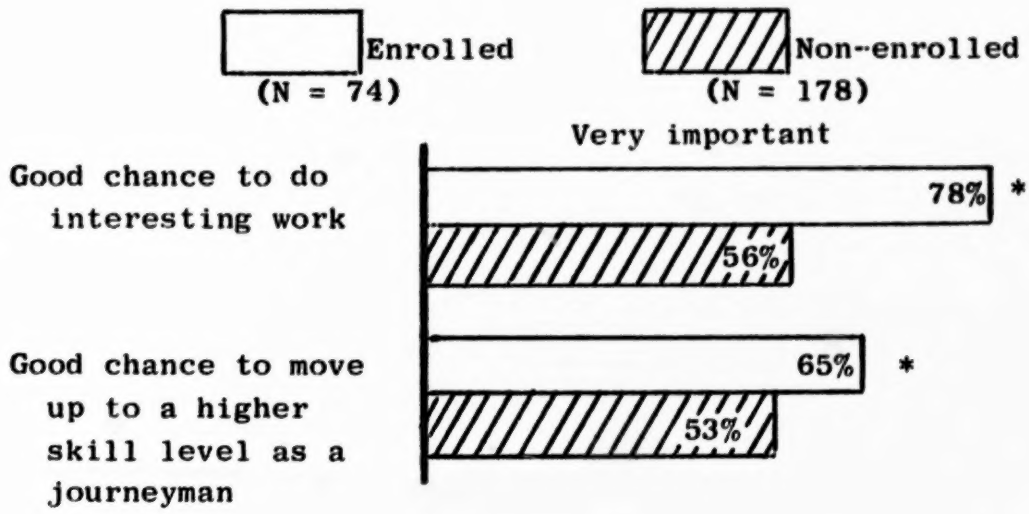
### TYPES OF COURSES THAT THE ENROLLED AND NON-ENROLLED JOURNEYMEN WOULD BE INTERESTED IN IF OFFERED



Enrolled journeymen, when compared with the non-enrolled journeymen, tend to differ as to the factors they consider to be important in their work. More of the enrolled journeymen rate "a good chance to do interesting work," and "a good chance to move up to a higher skill level as a journeyman," as very important (see Figure 26).

FIGURE 26

IMPORTANCE OF SELECTED JOB FACTORS TO THE ENROLLED AND NON-ENROLLED JOURNEYMEN



* Not significant

To summarize, the enrolled journeyman is younger and tends to have a greater need for training, either because he has less experience on the job, more family responsibilities, or both. Also, because he is convinced that a great number of changes will be occurring in the next five years, and that these changes will be beneficial in terms of improved job security, he seeks training so as to keep himself up to date in his area of activity. This observation is also applicable to the older journeymen who are over 46 years of age. He also tends to be less well satisfied with his current training for his work. In general, the enrolled journeyman hopes to move up to a higher skill level than he currently occupies, likes to do interesting and valuable work, and has found previous training experiences more to his liking than does the non-enrolled journeyman.

## Chapter 7

## THE EXPERIMENTAL PROGRAM

As mentioned in Chapter 1, evaluation of the effectiveness of new teaching techniques in the training of journeymen electricians was designed to be carried out in four steps. The results of Steps 1 and 2 are described in Chapters 2 through 6 of this report. The third and perhaps the most important step of the research was to carry out the training itself, and Step 4 was the assessment of the effects on trainee performance and attitudes.

To review briefly, there were two over-all objectives of the study: (1) to identify those factors which facilitate or hinder the effective training of journeyman electricians, and (2) to determine the effectiveness of new teaching aids, such as teaching machines, in holding the interest of enrolled trainees and in leading to enrollment in any subsequent programs.

### Procedures

Ninety-six journeyman electricians,* all of whom volunteered for training, were randomly assigned to three training groups or instructional modes. Each group spent three hours once each week at an evening class. The instructional modes ranged from the individualized, self-paced instruction of Mode 1 through the combined lectures and automated study of Mode 2 to the group-oriented lecture instruction of Mode 3.

Each of the instructional modes was broken into two classes held on separate nights. This permitted the instructors to rotate in Modes 2 and 3 and partialed out the effects of any differences in instructor abilities or of bias against the use of self-instructional techniques.

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* Three of the enrollees were self-employed as contractors but all had moved up to this position from the journeyman ranks.

Note that in Mode 1 the instructors served as monitors during the self-instructional portion of the class.

Mode 1, taught primarily by self-paced instruction, used the AutoTutor machine. A typical class began with the student's reading mimeographed* one- to two-page reviews of the previous week's lesson, which were distributed by the monitor at the beginning of the class; these consisted of pre-punched pages for easy inclusion into a three-ring notebook. After the reading, each student progressed on the machine at his own pace for approximately an hour and a half, when all were given permission to take a 10-minute coffee break. A number of men, knowing they were behind other members of the class, generally worked through the coffee break. When the class resumed, the monitor assigned laboratory experiments and distributed equipment for individual or group activity.

In Mode 1, the instructors served as monitors during the self-instructional period by answering an individual student's questions and working with any student who requested assistance. Instructors who were not trained lecturers (see Figure 1) were qualified through their extensive background as journeyman electricians to explain the subject matter and answer almost any question raised by the students.

Mode 2 combined machine with live instruction. Usually the trained instructor reviewed the previous week's lesson and outside reading assignments during the first half-hour of the class, although this procedure varied from time to time. The instructor was sometimes forced to wait for late students to appear before beginning his review and occasionally did not begin the review until half to three-quarters of an hour after class opened. In general, the instructor discussed in the review the identical information contained in the handout reviews distributed in Mode 1, but he could not always adhere to the pre-planned review outline when the students' questions required answers. After the review the men worked for approximately one and one-half hours on the AutoTutor machines, then took a coffee break. Following that period, they returned to work in the laboratory for the remainder of the session.

Mode 3 served as a control; it was taught by the conventional lecture method. The instructor tried to follow the same sequence of

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* Mimeographing saved the expense of microfilming these reviews for presentation on the AutoTutor machine.

information and arguments as was presented on the machine and, as far as possible, the lectures contained the same subject matter in the same sequence as that which was introduced in Modes 1 and 2. The effort did not always succeed, however, as the instructors would inadvertently introduce segments of the program in the wrong sequence. Where relevant, audiovisual aids were employed (see Chapter 5). Following approximately an hour and a half to two hours of lecture, and a coffee break, the instructor introduced the laboratory exercise in the same manner as that described for the two experimental groups.

As far as possible, all three groups were exposed to the same sequence and quality of information. Each group was given an opportunity for review, either by the instructors or by means of handout materials. After the third week of training, weekly review tests were introduced. These were administered immediately after completion of the instructional portion of the class and were self-administered and scored by the students. (No attempt was made to record the scores as the tests were intended to serve as self-diagnostic tools.) Identical outside reading assignments were given to all three classes, and each instructor was asked to follow the same sequence of laboratory demonstrations and experiments.

Although it had been intended that each class have approximately one hour of laboratory work, or a total of seven hours during the first half of the semester (the period of the experimental study), this was not achieved; a total of four to five hours of actual lab work would be more accurate. The practicality of the lab assignments also fell short of the objectives laid down in Chapter 4. Part of this two-fold failure can be attributed to the self-pacing feature of programed instruction: after two or three lessons, the number of frames covered by the faster students outdistanced that of the slower students by as much as one-third of the total frames in the first half-semester of the course. To assign compatible lessons became almost an impossibility. The Mode 3 classes, which were to follow the sequence of lessons laid down in Modes 1 and 2, were also out of phase with the planned program.

Before and after the experiment, achievement and attitude measures were administered; this permitted comparison of the relative effectiveness of the three modes of instruction. The Wesman Personnel Classification Test (PCT) and the pre-test of electrical knowledge were administered at the beginning of the first class. (See Volume II for a detailed description of the items selected for use in the various tests.) The mid-term examination was administered after the completion of the 8th week of instruction. The test scores of the journeymen in the training program were also compared with those of a group of journeymen who did not participate.

Attendance records were kept by the instructors and maintained on IBM cards. Arrangements were made to have each instructor advise his particular class of their attendance record, because of the competition for the dinner to be awarded to that group which had the best record of attendance at the completion of the training. During the first eight weeks, two make-up sessions were provided for the journeymen who were unable to attend a particular night's session. These were scheduled on Saturday mornings, permitting a previously absent student to qualify for a make-up of attendance. Such make-up sessions were also utilized by students in the programed instructional mode who found themselves considerably behind others in their group; in this way they were able to stay somewhat abreast of the faster students.

## Hypotheses

It was hypothesized that programed instruction would offer the following advantages over conventional vocational education classes:

1. Self-pacing, immediate feedback, and the step-by-step learning procedure employed by programed instruction should result in more positive attitudes toward training than does the more conventional form of instruction. Substitution of a non-critical, objective, and eminently patient programed "instructor" for the conventional classroom teacher should yield positive results in terms of student interest and satisfaction with the learning experience, and self-pacing and the AutoTutor's branching procedure should better serve the individual's specific informational requirements and varied background. Also, immediate feedback on the accuracy of response should introduce short-range goals better tuned to the interest of such groups as journeyman electricians since most adults dislike postponing a knowledge of how well they are doing in a class until the mid-term exam or the end of the term. Course credit or certification at the completion of the semester are less important than is the experience of success at each step of the way.

2. The care with which programs were developed and pre-tested should better adapt the teaching material to the backgrounds and experiences of the students because the course material was directly related to the students' work. The training objectives were first stated in operational terms, were then related point by point to the instructional material, and the skilled programers attempted to match the sequence of items with the capabilities of the trainees by pre-testing the program on a small sample of journeymen. Where response errors indicated, the program was modified to fit the requirements of the group. All three

of the instructional modes followed the same outline. Therefore the over-all training program should be more successful in meeting the expectations of the journeyman than previous courses covering the same topic.

3. Previous research had shown that programed instruction produces a more uniform and higher level of performance than do conventional courses. Thus in the two auto-instructional modes a significantly higher over-all mean score and a lower standard deviation should occur in the conventional mode.

4. Because of (a) the care with which the programed instructional materials were developed, and (b) the concern with relating the course of instruction to specific job needs, the trainees should progress through the assigned materials at a faster rate than in conventionally-developed courses. Thus, the over-all program should, in terms of the time invested by students, compare favorably with non-programed courses.

## Findings

The following data were obtained from the students enrolled in each of the three instructional modes: (1) PCT total scores, (2) PCT verbal scores, (3) PCT numerical scores, and (4) scores on a test of previous knowledge of electricity, the "pre-test," developed by the research team (see Volume II). Both the PCT and the pre-test were administered on the first day of the semester. The students' scores on the pre-test were used as a baseline for measuring the growth in electrical knowledge during the first half of the semester.

A "post-test" of knowledge of electricity, also prepared by the research team, was administered at the middle (9th) week of the training program. The items used in the post-test were different from those employed in the pre-test. This guarded against changes in test performance that might be due to experience with the specific test items instead of resulting from the training program.

The items for both tests were selected for content validity by the course instructors and by experienced electricians from within San Mateo County. In general the test items were patterned after exam items used in other introductory courses in industrial electronics.

The reliabilities of the tests were assessed by the split-half method.* Correlations were computed between the odd and even items of the tests, and the Spearman-Brown correction for length was applied. The pre-test yielded a corrected split-half reliability of .971, the post-test a reliability of .962, based on N's of 94 and 62 respectively. The correlation between the pre- and post-tests was .654, which is significant at the .01 level, for an N of 63.

## Comparison of Instructional Modes for Differences in Student Characteristics

Figures 27 and 28 illustrate that for the total population of enrolled journeymen the pre- and post-test scores are symmetrically distributed about the mean.

An analysis of variance, including mode of instruction, PCT scores, and pre-test scores, was carried out. No significant differences existed between the three instructional modes; within group variances were relatively large, as shown in Tables 1 and 2. Thus it may be assumed that the mode samples were not significantly different on either the PCT or the pre-test.

The auto-instructional Modes 1 and 2 produced a higher level of performance on the post-test than did the conventional instruction in Mode 3, although the differences were not statistically significant. Table 3 reports the means and standard deviations of each instructional mode for the pre- and post-test scores as well as for the scores obtained in the PCT. Uniformity of performance in the programed modes was less than in the conventional mode.

Students who knew more about the fundamentals of electricity before enrolling in the course, as measured by the pre-test, were able to perform significantly better on the mid-term examination after training in Mode 1 than did those with similar backgrounds but who were trained in Mode 3.

---

* The calculation of reliability estimates by the split-half method involves dividing a test into two equivalent halves. Subjects' scores on the separate halves are then correlated. Since this procedure reduces the test's length by half, the resultant reliability coefficient is ordinarily corrected to provide an estimate of the reliability of a test of the original length.

FIGURE 27

DISTRIBUTION OF PRE-TEST SCORES*

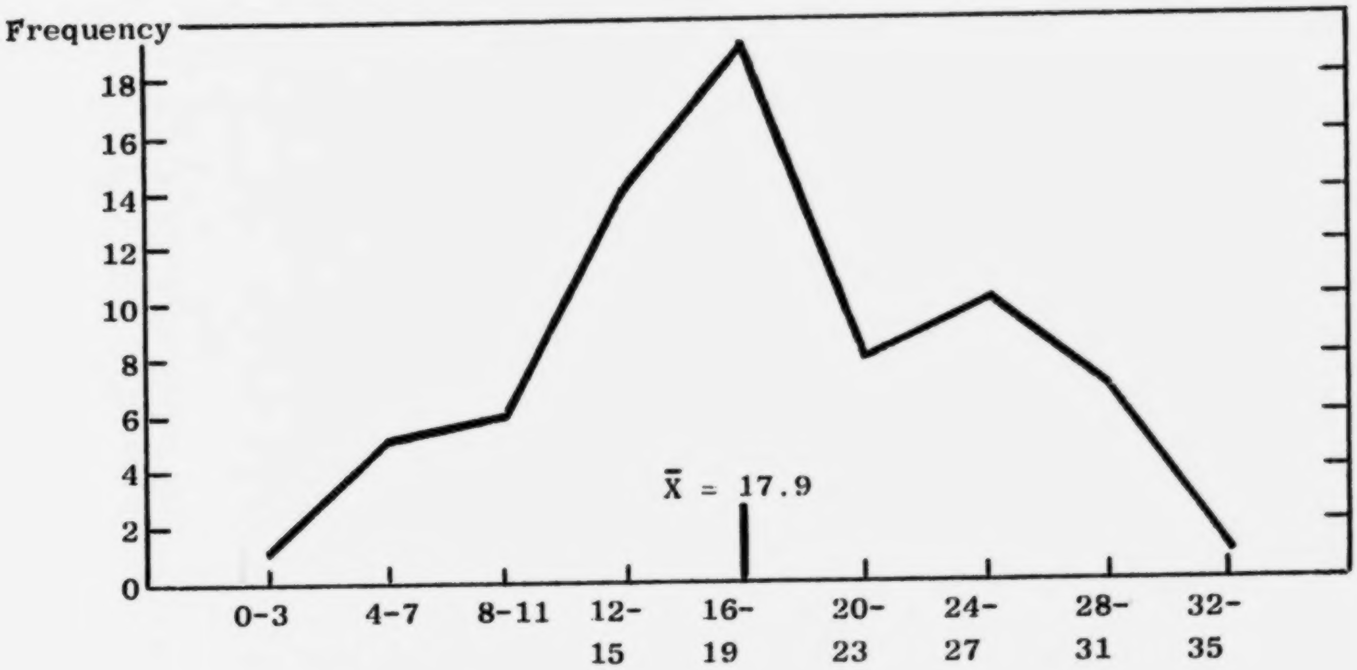
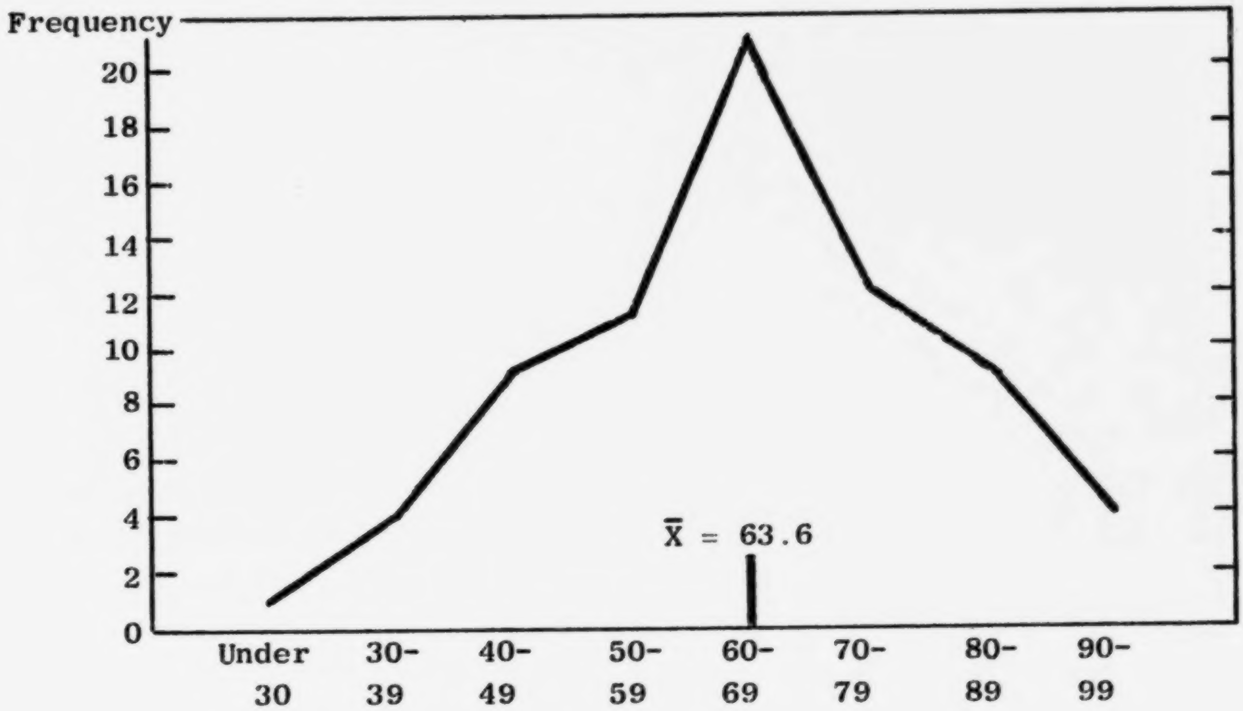


FIGURE 28

DISTRIBUTION OF POST-TEST SCORES*



* See text.

Table 1

ANALYSIS OF VARIANCE ON
PRE-TEST OF KNOWLEDGE OF ELECTRICITY
(BY MODE OF INSTRUCTION)

| Source of Variation | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Between modes | 45.8 | 2 | 22.9 | 0.455<br>($p>7.50$) |
| Within modes | 3,626.2 | 69 | 50.36 | |
| Total | 3,672. | 71 | | |

Table 2

ANALYSIS OF VARIANCE ON
WESMAN PERSONNEL CLASSIFICATION TEST SCORES
(BY MODE OF INSTRUCTION)

| Source of Variation | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Between modes | 269.8 | 2 | 134.9 | 0.730<br>($p>.50$) |
| Within modes | 8,530.5 | 69 | 184.69 | |
| Total | 8,800.3 | 71 | | |

Table 3

AVERAGE SCORES DERIVED FROM THE PRE- AND POST-TESTS AND THE WESMAN PERSONNEL CLASSIFICATION TEST

| Mode | N[a] | PCT | | | | Pre-Test | | Post-Test | |
|---|---|---|---|---|---|---|---|---|---|
| | | V | N | Total | σ | Scores | σ | Scores | σ |
| 1 | 17 | 19.9 | 9.9 | 29.8 | 8.03 | 16.8 | 6.36 | 66.5 | 16.98 |
| 2 | 23 | 16.8 | 7.6 | 24.5 | 10.83 | 17.7 | 8.03 | 65.1 | 15.83 |
| 3 | 31 | 18.7 | 9.4 | 28.1 | 7.74 | 18.8 | 6.85 | 60.9 | 14.07 |

a. The reduction in numbers was due in part to fewer persons' taking the mid-term exam, and, in Mode 1, to the use of an early form of the mid-term exam which proved to be too long for the time allotted. Four students were unable to complete the exam and had to be eliminated from the sample. The exam was shortened prior to its use in subsequent classes.

The quartile distributions and medians of mid-term scores for trainees who were in the above- and below-average groups on the pre-test, are shown in Figure 29; this provided a partial control for pre-test knowledge. Those who had above-average knowledge of the course material prior to training were able to progress more rapidly in the auto-instructional modes than those who had a similar knowledge in the conventional mode. A test of the mode and pre-test interaction produced an F of 4.16, which is significant at less than the .05 level (see Appendix A).

It should be observed that the better students in Mode 1, i.e., those who moved more quickly through the programed material, were given supplemental material on parallel and series circuits. By contrast, those in the conventional mode who had more knowledge initially were held to the information presented by the instructor. He had to gear his progress to the average rate of the class and could not take time to work individually with the more advanced students.

The data suggest that those who were below-average on the PCT did better in Mode 1 than in Mode 3. Figure 30 reports quartile distributions and median scores for this group. The higher median and smaller dispersion for Mode 1, as contrasted with the distributions for Modes 2 and 3, suggest that self-paced instruction does permit the lower-ability student to achieve a higher level of performance than does traditional classroom instruction.

The average mid-term scores of the experiment-trained journeymen were contrasted with the scores of a group of journeymen from a class in blueprint reading offered at a junior college in a nearby county. In a procedure similar to that used on the first day of the experimental class, the PCT and a shortened version* of the mid-term examination were administered during a three-hour class period. This control group of 21 journeymen were matched on PCT scores with a randomly-selected group of experiment-trained journeymen distributed across all modes.

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* See Volume II for the questions selected for use in this short version, and note that because only half the number of test items were administered to this control group as were originally administered to the experimental groups on the mid-term exam, the scores of the control population were doubled. The correlation between the original and shortened versions was .94.

FIGURE 29

MID-TERM EXAMINATION SCORES FOR JOURNEYMEN SCORING ABOVE-AVERAGE AND BELOW-AVERAGE ON THE PRE-TEST OF KNOWLEDGE OF ELECTRICITY

| Group | Instructional Mode | N | Pre-test $\bar{X}$ | Pre-test $\sigma$ |
|---|---|---|---|---|
| Above Average on Pre-test | 1 | 6 | 24.2 | 3.2 |
| | 2 | 14 | 23.0 | 4.3 |
| | 3 | 18 | 23.5 | 4.5 |
| Below Average on Pre-test | 1 | 11 | 12.8 | 3.4 |
| | 2 | 9 | 10.6 | 4.9 |
| | 3 | 13 | 12.3 | 3.2 |

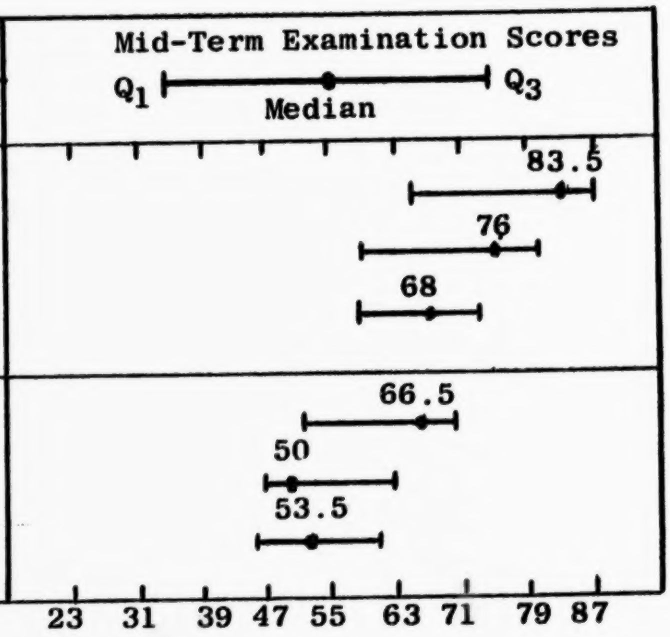
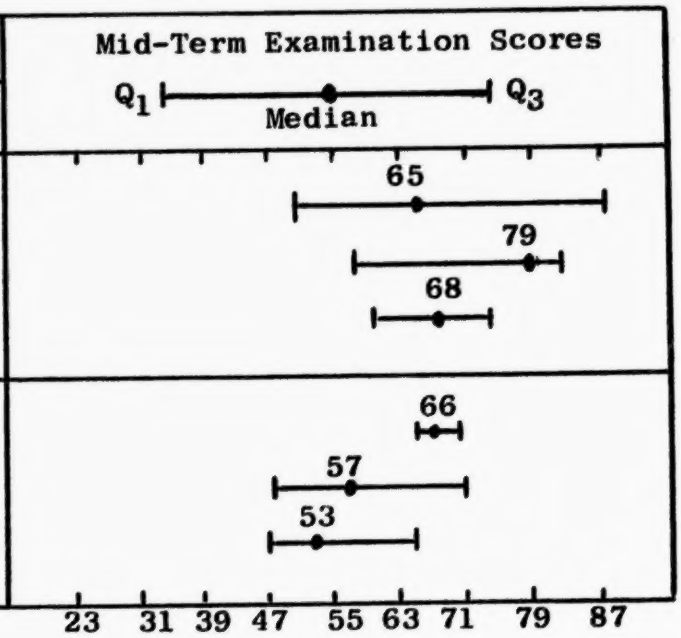


FIGURE 30

MID-TERM EXAMINATION SCORES FOR JOURNEYMEN SCORING ABOVE-AVERAGE AND BELOW-AVERAGE ON THE WESMAN PERSONNEL CLASSIFICATION TEST (PCT)

| Group | Instructional Mode | N | PCT $\bar{X}$ | PCT $\sigma$ |
|---|---|---|---|---|
| Above Average on PCT | 1 | 9 | 36.0 | 5.8 |
| | 2 | 11 | 34.1 | 3.6 |
| | 3 | 16 | 34.4 | 3.8 |
| Below Average on PCT | 1 | 8 | 22.9 | 2.9 |
| | 2 | 12 | 15.7 | 7.1 |
| | 3 | 15 | 21.5 | 4.6 |



The mid-term scores compared in this way:

| Group | N | $\bar{X}$ | $\sigma$ |
|---|---|---|---|
| Experimental | 21 | 58.7 | 13.8 |
| Control | 21 | 40.9 | 15.8 |

The test of significance of difference between means yielded a t of 3.80 ($p < .01$).

## Training Time

Over-all, the training program offered the review of the fundamentals of direct current theory in about half the time normally allocated to such a course. This was, in part, due to the way in which the programed instructional materials were developed. The thorough task analysis and specification of job needs enabled the designers of the course to reduce it to its essentials. This saving in time applied equally to each of the three instructional modes, which followed the same outline of course materials.

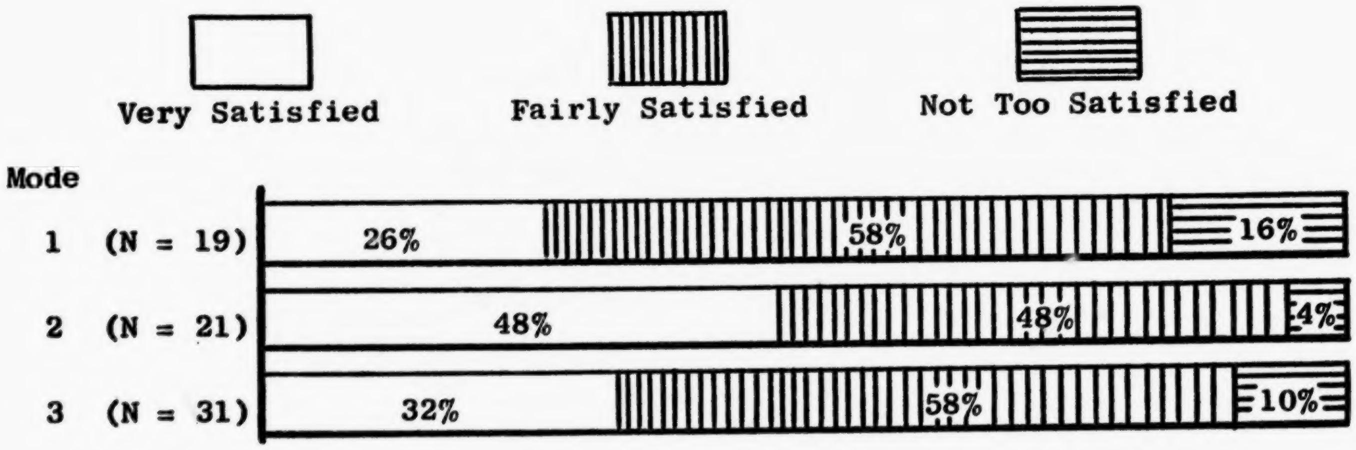
## Satisfaction with Programed Instruction

Mode 1 did not result in as high a level of over-all satisfaction with what was learned as did Mode 2, the combined machine-and-live instruction. Figure 31 indicates that almost half of the Mode 2 group reported they were "very satisfied" with what they had learned in the course,whereas only 26 percent of those in Mode 1 and 32 percent of those in Mode 3 did so.

Other measures of satisfaction with the training program indicated similar results (see Figure 32). All of the students in Mode 2 said they would sign up for the course again, if it were offered, as against 79 percent of Mode 1 and 87 percent of Mode 3. Similar numbers of journeymen said they would recommend the course to other journeymen. Interest in continued enrollment in a subsequent course was also much higher for the students in Mode 2. Eighty-six percent of this group said that

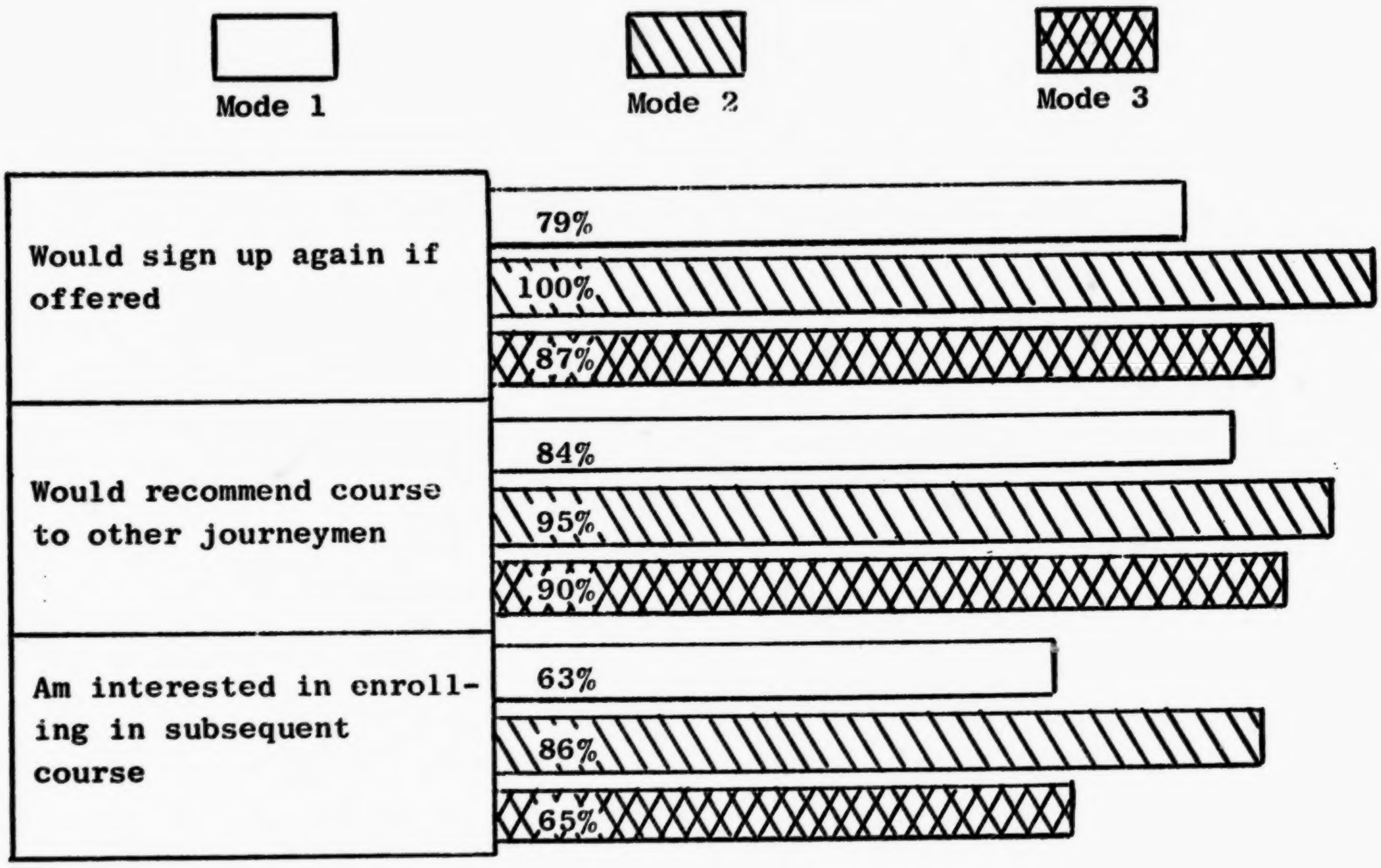
### FIGURE 31

ENROLLED JOURNEYMEN'S SATISFACTION WITH EXPERIMENTAL PROGRAM
(By Mode of Instruction)



### FIGURE 32

ENROLLED JOURNEYMEN'S INTEREST IN CONTINUING PARTICIPATION
IN EXPERIMENTAL AND SUBSEQUENT PROGRAMS



they would enroll in a course which continued where this one ended as against 63 percent in Mode 1 and 65 percent in Mode 3.*

## Programed Learning vs Live Instruction

Two-thirds of the students in Modes 1 and 2 said that it was easier to learn from the machine than from the instructor, as indicated in Table 4. However, the students in these same groups felt that there was "too little time" to cover the material presented while the students in the conventional classroom felt that the time allowed "was about right," as shown in Figure 33. On the other hand, trainees in the conventional classroom felt that they wanted more time in the laboratory, as Figure 34 shows.

On investigating the effectiveness of the lab portion of the course, the two experienced instructors who taught Modes 2 and 3 were compared with the two inexperienced instructors who monitored Mode 1. The students were asked to rate their instructors on "clarity of explanations," "ability to answer questions," and "encouragement of questions." These results are presented in Figure 35.

## Experimental Program vs Previous Courses

When asked to compare the experimental course with other courses they had taken, 73 percent of the journeymen felt that the experimental program was better. Comments (from the initial survey questionnaire) on the inadequacy of previous courses revealed that the journeymen felt the earlier courses were "too difficult," "not practical enough," and that "too much material was presented in too short a time." (See Chapter 4.) Figure 36 reveals that such responses were not generated by the experimental program. Ninety-three percent of the respondents found the difficulty of the lessons "about right" and 86 percent felt the length of each class was "about right"; 46 percent, however, felt that what they had learned in the course would not be too useful to them on the job. This latter finding was not unexpected, in that the course, although offered as an introduction to industrial electronics, was essentially a review of the fundamentals of electricity.

---

* Subsequently, it was demonstrated that this estimate of follow-up enrollment was accurate. Fifty men said they planned to enroll in the second semester program and 50 actually did so.

Table 4

EASE OF LEARNING WITH TEACHING MACHINE VS LIVE INSTRUCTOR (RATED BY ENROLLED JOURNEYMEN IN MODES 1 AND 2)

| | Percent | N |
|---|---|---|
| Teaching machines easier to learn from | 63% | 25 |
| Instructor easier to learn from | 12 | 5 |
| Not much difference | 17 | 7 |
| No response | 8 | 3 |
| | 100% | 40 |

FIGURE 33

ATTITUDES ON TIME TO COVER CLASS MATERIAL
(Expressed by Journeymen in Three Instructional Modes)

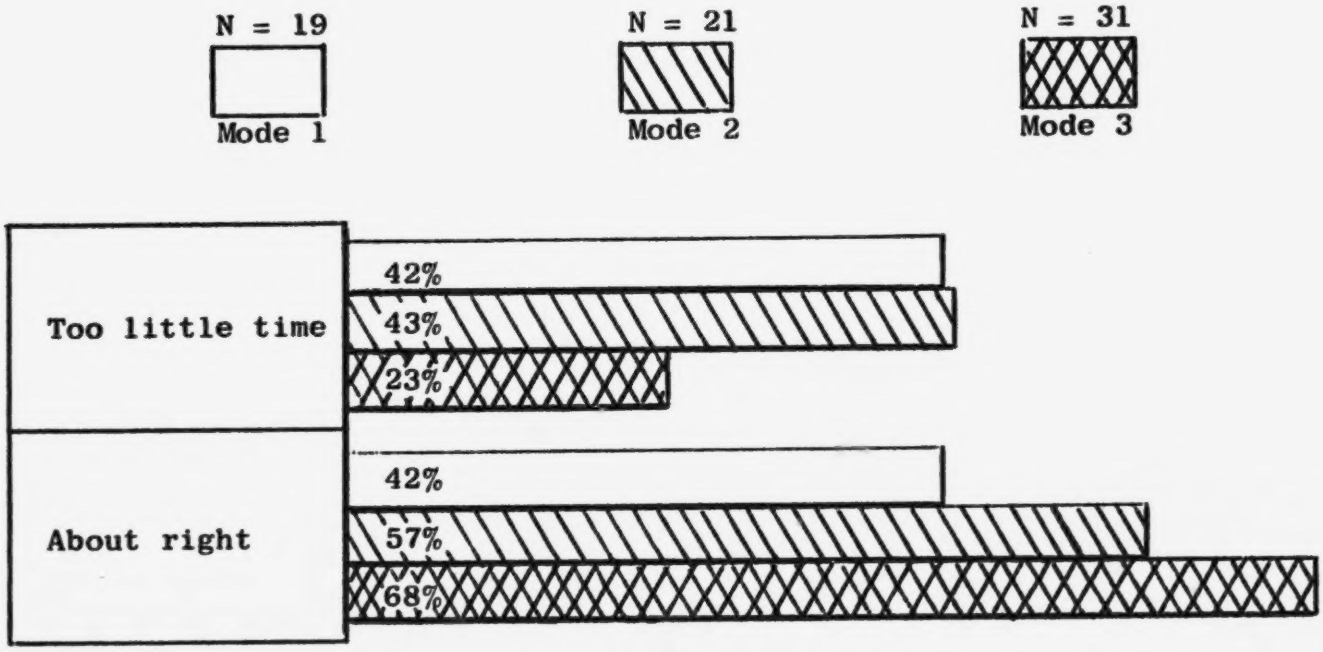


FIGURE 34

ATTITUDES ON TIME SPENT IN LABORATORY
(Expressed by Journeymen in Three Instructional Modes)

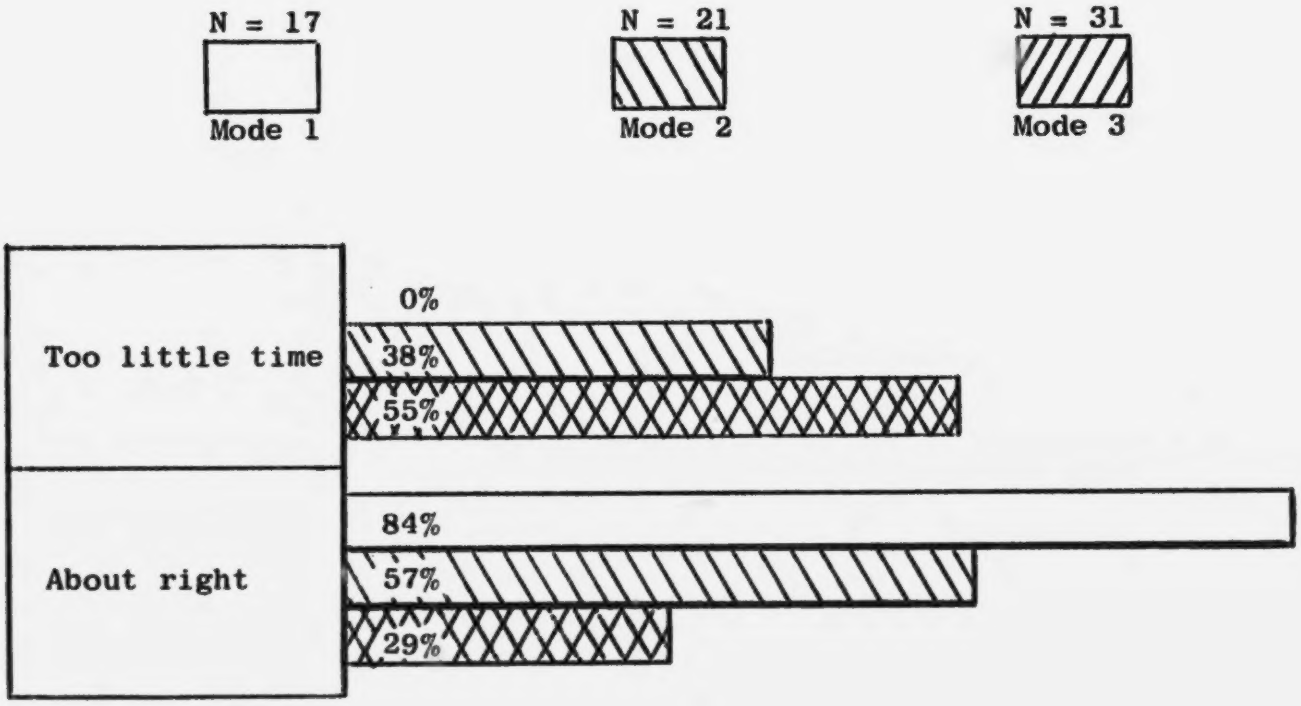


FIGURE 35

EFFECTIVENESS OF LAB INSTRUCTORS
(Rated by Journeymen in Three Instructional Modes)

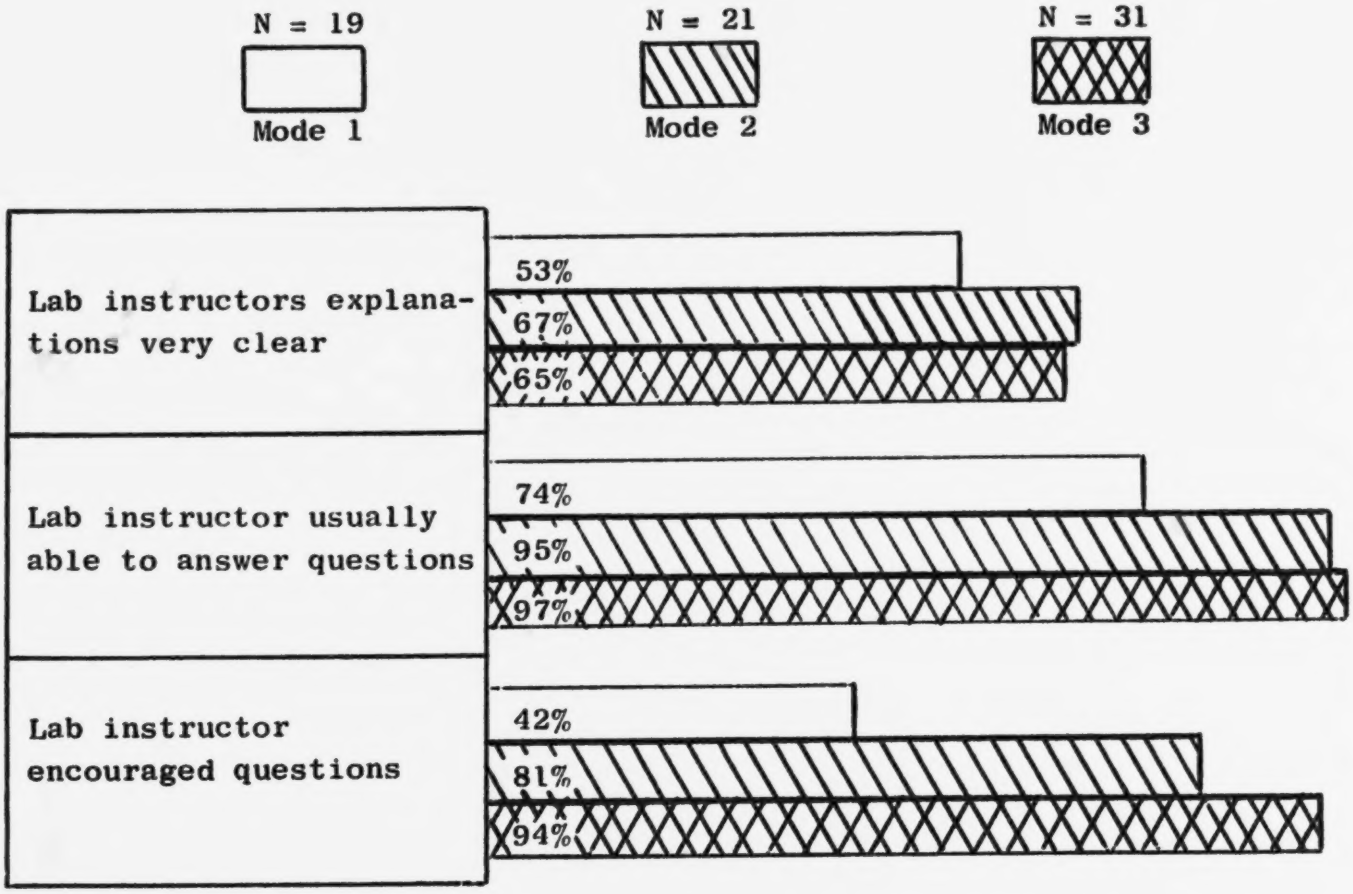
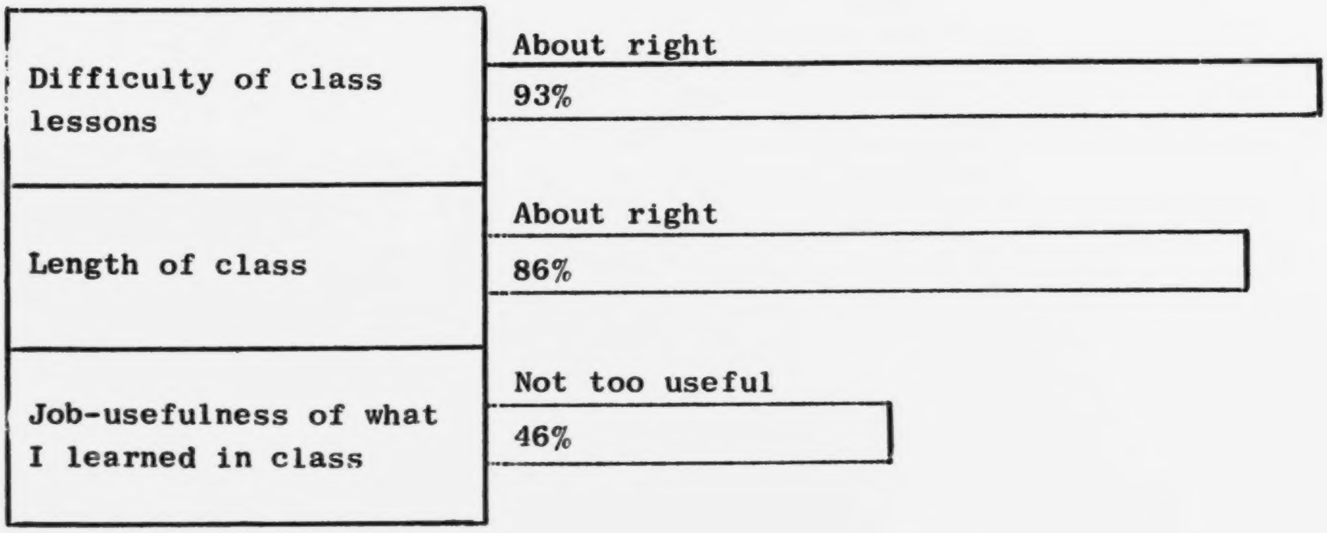


FIGURE 36

REACTIONS OF TOTAL GROUP OF ENROLLED JOURNEYMEN
TO VARIOUS ASPECTS OF EXPERIMENTAL PROGRAM (N = 71)



## Absences and Dropouts

The over-all absence rate during the experimental half of the semester was 5.5 percent; this figure excludes 10 men who dropped out of the course during this 9-week period. No differences between dropout rates for the three modes of instruction could be ascertained.

The absence rate was compared with those of two similar classes on the same subject offered by a nearby city college, one in the Fall of 1961, the other in the Fall of 1962. Both classes met two nights each week, for three or four hours per session, and for a total of 34 and 35 sessions respectively. The absence rates of the three courses are shown in Table 5. The absence rate for the experimental training program was 5.5 percent, as compared with absence rates of 37 percent and 17 percent in the other two courses.

Most of the dropouts in the experimental program had legitimate reasons for doing so. For example, one was transferred to a night shift, a second and third were hospitalized, a fourth was enlisted to teach an apprenticeship training program. The fifth and sixth felt that other activities conflicted. The seventh and eight reported that they felt the course to be too elementary. The remaining two men did not give their reasons.

Detailed treatment of the absence and attendance records for each instructional mode appears in Appendix A.

Table 5

ABSENCE RATES OF EXPERIMENTAL PROGRAM COMPARED WITH TWO SIMILAR PROGRAMS OFFERED AT ANOTHER JUNIOR COLLEGE

| | Initial Enrollment | Number of Drop-outs | Attendance (hours) | | |
|---|---|---|---|---|---|
| | | | Scheduled[a] | Actual | Percent Absent |
| Experimental program | 94 | 10 | 2,349 | 2,220 | 5.5% |
| Program X | 16 | 3 | 1,365 | 867 | 37. |
| Program Y | 22 | 7 | 1,632 | 1,353 | 17. |

a. Excludes drop-outs. Number of scheduled hours = number of enrollees × number of scheduled hours per week × number of weeks of program.

# Appendix A

# ANALYSIS OF VARIANCE TABLES AND ABSENCES AND DROPOUTS DATA

## ANALYSIS OF VARIANCE: EFFECTS OF TEACHING MODES ON PERFORMANCE
After Controlling on Previous
Knowledge of Course Materials

| Source of Variation | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Teaching modes, after controlling on pre-test score | 963.3 | 2 | 481.6 | 4.16<br>($p<.05$) |
| Residual sum of squares | 7,756.4 | 67 | 115.8 | |
| Sum of squares about the mean after controlling on pre-test of knowledge | 8,719.7 | 69 | | |

## ANALYSIS OF VARIANCE: INTERACTION EFFECTS OF TEACHING MODE WITH PREVIOUS KNOWLEDGE OF COURSE MATERIALS

| Source of Variation | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Interaction of pre-test score with teaching mode | 157.7 | 2 | 78.85 | .674<br>($p > .10$) |
| Residual sum of squares | 7,598.7 | 65 | 116.9 | |
| Sum of squares about the mean after controlling on pre-test knowledge | 7,756.4 | 67 | | |

## ANALYSIS OF VARIANCE: CORRELATION OF PCT SCORES WITH PERFORMANCE
### After Controlling on Previous Knowledge of Course Materials and Fitting Teaching Mode Effects

| Source of Variation | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| PCT Scores after controlling on pre-test score and fitting teaching mode effects | 353.7 | 2 | 176.85 | 1.55 |
| Residual sum of squares | 7,402.7 | 65 | 113.89 | ($p>.10$) |
| Sum of squares about the mean after controlling on pre-test knowledge and fitting teaching mode effects | 7,755.4 | 67 | | |

## ABSENCES AND DROPOUTS DATA OF JOURNEYMAN ELECTRICIAN TRAINING PROGRAM
## (FIRST 9 WEEKS)

| | | | Number of Class Hours | | |
|---|---|---|---|---|---|
| Teaching Mode | Initial Enrollment | Drop-outs | Scheduled | Actual | Percent Absent |
| 1 | 29 | 4 | 675 | 621 | 8. % |
| 2 | 30 | 2 | 756 | 723 | 4.4 |
| 3 | 37 | 3 | 918 | 876 | 4.6 |
| Total | 96 | 9 | 2,349 | 2,220 | 5.5% |

## Appendix B

## PERCENTAGE DISTRIBUTION OF RESPONSES TO MAILED SURVEY QUESTIONNAIRE
(N = 252)

## Appendix B

### PERCENTAGE DISTRIBUTION of Responses

**BACKGROUND**

1. Which one of the following most closely describes your present classification? (Check one)

8-1 9 General Foreman
-2 33 Foreman
-3 4 Estimator
-4 48 Inside wireman
-5 - Technician
-6 .3 Lineman
-7 .3 Groundman
-8 7 Maintenance man
9-1 - Motorshop man
-2 .2 Other (please write in)

2. How long have you worked in your present classification? (Check one)

10-1 4 Less than 6 months
-2 4 More than 6 months, less than 1 year
-3 11 1-2 years
-4 12 3-4 years
-5 18 5-7 years
-6 9 8-10 years
-7 15 11-15 years
-8 19 16-25 years
-9 8 Over 25 years

3. How long have you been a journeyman? (Check one)

11-1 2 Less than 6 months
-2 2 More than 6 months, less than 1 year
-3 7 1-2 years
-4 10 3-4 years
-5 10 5-7 years
-6 10 8-10 years
-7 24 11-15 years
-8 27 16-25 years
-9 12 Over 25 years

4. Present place of work: (Check all that apply)

12-1 72 Commercial
13-1 17 Hospital
14-1 52 Residential
15-1 54 Apartments
16-1 36 Schools
17-1 58 Industrial construction
18-1 29 Industrial maintenance
19-1 18 Line and underground work
20-1 15 Motor work
22-1 Other (please write in)

5. Age group: (Check one)

23-1 4 25 and under
-2 13 26-30
-3 20 31-35
-4 16 36-40
-5 15 41-45
-6 12 46-50
-7 11 51-55
-8 6 56-60
-9 3 61 and over

6. Are you married? (Check one)

24-1 92 Yes
-2 6 No
2

7. Number of children? (Check one)

25-1 12 None
-2 21 1
-3 29 2
-4 21 3
-5 11 4
-6 5 More (please write in)

8. What do you like to do in your spare time? (Check all that apply)

26-1 58 Sports (examples: bowling, archery)
27-1 45 TV
28-1 31 Music
29-1 46 Reading
30-1 33 Social (example: playing cards)
31-1 38 Hobbies
32-1 31 Other (please write in)
11 N.A.

9. About how much time on the average do you spend on these spare-time activities a week? (Check one)

33-1 - 0
-2 25 1-5 hours
-3 38 6-10 hours
-4 26 16-20 hours
-5 9 21 and over hours
2 N.A.

10. If you spend time on hobbies, do any of them relate to your work? (Examples: ham radio operator, building your own hi-fi equipment)

34-1 29 Yes
-2 68 No
3 N.A.

11. What kind of education would you like your children to have? (Check one)

35-1 3 High school graduate
-2 4 High school plus some vocational training
-3 8 Extended vocational training beyond high school
-4 6 Junior college
-5 71 Four-year college
-6 2 Other (please write in)

12a. What do you hope to be doing 5 years from now? (Check one)

36-1 26 Continue working in my present classification as a journeyman
-2 46 Continue working as a journeyman but in a different classification
-3 0 Work at some other job in the construction trade (sheet metal worker, for example)
-4 3 Work as an electronic technician in a manufacturing company
-5 16 Contracting on my own
-6 5 Retire
-7 4 Other (please write in)

b. If you said you hoped to be working as a journeyman but in another classification, which of the following classifications would you choose? (Check one)

37-1 36 General Foreman
-2 35 Foreman
-3 2 Inside wireman
-4 17 Estimator
-5 7 Technician
-6 - Lineman
-7 - Groundman
-8 2 Maintenance man
38-1 - Motorshop man
-2 1 Other (please write in)

## ATTITUDES TOWARD TRAINING

13. What type of problems on-the-job do you run up against which a training program might be of some help in solving? (please write in)[a]

________________________________

a/ (See comments attached)

________________________________

________________________________

14. How satisfied are you with the training you have had for your present work? (Check one)

39-1 ____Very satisfied
-2 ____Fairly satisfied
-3 ____Satisfied in some ways, dissatisfied in others
-4 ____Fairly dissatisfied
____Very dissatisfied

15. Who taught you the most about your present job? (Check one on each line)*

| | | | Taught Me | | | | |
|---|---|---|---|---|---|---|---|
| | | | A Great Deal 1 | Quite A Lot 2 | Some 3 | A Little 4 | None 5 |
| 40 | a | My supervisor or foreman | 23 | 21 | 31 | 18 | 8 |
| 41 | b | My instructors in various voluntary classes | 13 | 17 | 37 | 19 | 14 |
| 42 | c | The other men who were in training with me | 3 | 11 | 40 | 24 | 22 |
| 43 | d | The men who were already working on the job | 45 | 30 | 18 | 5 | 2 |
| 44 | e | My instructors in the military service | 7 | 9 | 15 | 12 | 57 |
| 45 | f | My instructors in the apprentice training program. | 22 | 22 | 30 | 9 | 16 |

* Tabulations exclude "No Responses" from the percentage base.

16. Suppose you need to learn more about a job. How much can you learn in these ways? (Check one on each line)

| | | | A Great Deal 1 | Quite A Lot 2 | Some 3 | A Little 4 | Very Little 5 |
|---|---|---|---|---|---|---|---|
| 46 | a | Attending classes on the theory of electricity and electronics | 26 | 26 | 24 | 8 | 4 |
| 47 | b | Attending classes on specific job problems or operations (such as welding) | 29 | 36 | 14 | 4 | 2 |
| 48 | c | Reading and studying on my own | 20 | 28 | 27 | 10 | 4 |
| 49 | d | Watching and talking with the men who are actually doing the job | 36 | 36 | 14 | 4 | 1 |
| 50 | e | Doing the job myself under the guidance of other men. | 56 | 24 | 5 | 2 | 2 |

17. Have you taken any adult education courses in the last 5 years? (Check one)

33-1 57 Yes
-2 42 No
1 N.A.

If NO, please omit questions 18 through 20.

18. If YES, think back to the poorest course you've taken in the last 5 years. What was wrong with it? (Check all that apply)

51-1 46 Course was not practical enough
52-1 33 Course was not related to my job
53-1 10 Teacher was not qualified
54-1 47 Too much material in too short a time
55-1 6 Never had a chance to ask questions
56-1 28 Teacher never tried to find out if the class understood what he was saying
57-1 15 One or two students tried to dominate the discussion
59-1 31 Course was over my head (for example, needed more math training to understand the material)
60-1 2 Couldn't smoke
61-1 6 Other (please write in)

19. How many job-related and non-job related courses have you enrolled in in the past 5 years? (Check one in each column)

| | | Job related | | | Non-job related |
|---|---|---|---|---|---|
| 64-0 | 2 | 0 | 65-0 | 13 | 0 |
| -1 | 31 | 1 | -1 | 27 | 1 |
| -2 | 28 | 2 | -2 | 7 | 2 |
| -3 | 18 | 3 | -3 | 3 | 3 |
| -4 | 7 | 4 | -4 | 2 | 4 |
| -5 | 2 | 5 | -5 | 1 | 5 |
| -6 | | 6-8 | -6 | 3 | 6-8 |
| -7 | | 9 and over | -7 | 1 | 9 and over |
| | 12 | N.A. | | 43 | N.A. |

20. How many outside courses have you completed in the last 5 years? (Check one)

63-0 22 0
-1 25 1
-2 20 2
-3 13 3
-4 5 4
-5 1 5
-6 3 6-8
-7 2 9 and over
7 N.A.

21. How do the other journeymen that you know feel about voluntary training programs? (Check one)

62-1 19 Seem to like them very much
-2 49 Seem to like them fairly well
-3 21 Don't seem to like them too wel
-4 3 Don't seem to like them at all
7 N.A.

22. Which of the following courses woul you be interested in enrolling in i they were offered next fall? (Chec all that apply)

66-1 69 Industrial Electronics
67-1 16 Welding
68-1 50 Circuitry of industrial equipment
69-1 25 Foreman training
70-1 27 Blueprint reading
71-1 59 Motor controls and control circuits
72-1 38 Use of new tools and equipment
73-1 7 Other (please write in)

23. Would you sign up for a course in Industrial Electronics if it were offered this coming September?

74-1 65 Yes -2 30 No

If NO, please state your main reasons for not wanting to enroll. (Please write in)

## PREVIOUS TRAINING AND EXPERIENCE

24. Previous military service? (Check one)

8-1 66 Yes -2 32 No 2 N.A.

If NO, please omit the following:

a. When did you serve? (Check as many as apply) N = 166

9-1 17 Before WW II
10-1 61 WW II
11-1 31 Korea
12-1 7 Other (please write in)

________________________________

b. Length of service: (Check one)

13-1 4 Less than 1 year
-2 23 1-2 years
-3 53 3-4 years
-4 18 5 or more years
3 N.A.

c. Did you receive any training as an electrician while in service? (Check one)

14-1 38 Yes -2 59 No 3 N.A.

If YES, please specify what type of training.

________________________________

________________________________

________________________________

d. Was any of the experience in the service helpful to your present work as a journeyman? (Check one)

15-1 51 Yes -2 44 No

If YES, please describe:

________________________________

________________________________

________________________________

25. Some men gain new experience by working for several contractors. Other men prefer to work for just one contractor. (Check one)

16-1 9 I prefer to work for a large number of contractors
-2 12 I prefer to work for quite a few contractors
-3 38 I prefer to work for just a few contractors
-4 40 I prefer to work for one contractor
1 N.A.

26. What is the highest grade you completed in school? (Check one)

17-1 7 Elementary school
-2 18 Some high school
-3 23 Completed high school
-4 51 Some college
-5 2 Completed college

a. If you went to college, did you receive a degree? (Check one)

18-1 64 No degree received
-2 33 Associate degree
-3 2 Bachelor degree

b. Have you ever gone to a trade school? (Check one)

19-1 40 Yes -2 49 No 11 N.A.

If YES, what type of trade school? (Please write in)

________________________________

________________________________

27. Are you a graduate apprentice? (Check one)

20-1 64 Yes -2 35 No 1 N.A.

If NO, please omit the following:

a. How long ago did you complete your training? (Check one)

21-1 2 Less than 6 months ago
-2 2 More than 6 months, less than 1 year ago
-3 11 1-2 years ago
-4 17 3-4 years ago
-5 15 5-7 years ago
-6 10 8-10 years ago
-7 20 11-15 years ago
-8 20 16-25 years ago
-9 2 Longer (please write in)

b. How long were you in the program? (Check one)

22-1 0 Less than 6 months
-2 0 More than 6 months, less than 1 year
-3 2 1 year
-4 7 2 years
-5 13 3 years
-6 68 4 years
-7 7 5 years
-8 2 Longer (please write in)
2 N.A.

c. What did you think of your apprentice training? (Check all that apply)

23-1 59 Good training for current job
-2 3 Took too long
-3 48 Teachers were good
-4 17 Teachers were not very good
-5 30 Not enough opportunity to try different types of jobs
-6 10 Too much crammed into the training period
-7 7 Didn't really help in my present work
-9 9 A lot of it was over my head
24-1 23 Wrong things were stressed
-2 28 Other comments (please write in)

d. In general did you like or dislike the years you spent in the apprentice program? (Check one)

25-1 30 Liked it very much
-2 22 Liked it quite well
-3 27 Liked it fairly well
-4 7 Didn't like it too much
-5 1 Didn't like it at all

## CHANGES ON THE JOB

28. Have there been many changes in your line of work in the past 5 years? (Check one)

26-1 14 No real changes
-2 28 A few changes
-3 30 Some changes
-4 27 Many changes
1 N.A.

29. If you feel there have been changes, what kind have these been? (Check all that apply)

27-1 3 Haven't been any changes
28-1 22 Less physical labor
29-1 75 New types of equipment
30-1 36 More automation
31-1 56 Greater variety of work
32-1 35 More electronic installations
33-1 22 More assignments requiring background and training that I don't have
34-1 2 Other (please write in)

________________________________

________________________________

30. How many changes do you think will occur in your line of work in the next 5 years? (Check one)

35-1 4 No real changes
-2 19 A few changes
-3 33 Some changes
-4 41 Many changes
2 N.A.

31. What changes do you expect to see in the next 5 years? (Check all that apply)

36-1 4 Don't expect any substantial changes
37-1 17 More motor hook-ups
38-1 74 Greater number of control circuit installations
39-1 43 Greater use of test equipment (ohmmeter, ammeters, etc.)
40-1 33 More trouble shooting of lighting circuits, motor and control circuits
41-1 55 More specialization
42-1 77 Increased knowledge of electronics
43-1 5 Other (please write in)

________________________________

________________________________

32. Do you think that the construction business in San Mateo County will be better or worse in the next few years than it is now? (Check one)

44-1 32 Business will be a lot better
-2 31 Somewhat better
-3 31 About the same as now
-4 4 Somewhat worse
-5 1 Business will be a lot worse
1 N.A.

33. Taking all things into consideration, would you say your future as a journeyman in San Mateo County looks better or worse than a few years ago? (Check one)

45-1 40 My future looks much better than a few years ago
-2 31 Somewhat better
-3 25 About the same as it did
-4 1 Somewhat worse
-5 1 My future looks much worse than a few years ago
1 N.A.

34. Different people want different things out of their jobs. How important are the following things to you on your job? (Check one in each line across)

| K | | Very Important 1 | Quite Important 2 | Somewhat Important 3 | Not Too Important 4 | Not At All Important 5 | N.A. |
|---|---|---|---|---|---|---|---|
| 7 | 46- Good chance to move up to a higher skill level as a journeyman | 56 | 18 | 10 | 5 | 2 | 9 |
| 11 | 47- Not having to work too hard | 3 | 9 | 27 | 36 | 16 | 9 |
| 2 | 48- Getting along well with the people I work with | 64 | 25 | 5 | 0 | 0 | 7 |
| .5 | 49- Steady work and steady wages | 67 | 20 | 5 | 1 | 0 | 7 |
| 3 | 50- Good chance to do interesting work | 59 | 29 | 5 | 2 | 0 | 4 |
| 1 | 51- Good chance to turn out good quality work | 74 | 20 | 2 | 0 | 0 | 3 |
| 8 | 52- Getting along well with my foreman | 45 | 26 | 17 | 2 | 1 | 9 |
| 6 | 53- Getting along well with the contractor | 49 | 28 | 12 | 3 | 0 | 7 |
| 10 | 54- High wages | 23 | 33 | 27 | 8 | 1 | 8 |
| 9 | 55- Pensions and other old-age security benefits | 42 | 26 | 16 | 8 | 2 | 6 |
| 4.5 | 56- Good physical working conditions | 61 | 26 | 7 | 0 | 0 | 5 |

35. All in all, how satisfied are you with your present job? (Check one)

57-1 42 Very satisfied
-2 40 Fairly satisfied
-3 12 Neither satisfied nor dissatisfied
-4 2 Fairly dissatisfied
-5 0 Very dissatisfied
2 N.A.

36. How would you rate your own background and training in handling current job assignments? (Check one)

58-1 28 About average - as good as other journeymen
-2 40 A little above average - a little better than the other journeymen
-3 25 Quite a bit above average - quite a bit better than the rest of the journeymen
-4 5 A great deal above average - better than any of the other journeymen.
3 N.A.

## Appendix B (Continued)

### Write-in Responses on Question 13 of Mailed Survey Questionnaire

> "What types of problems on-the-job do you run up against which a training program might help in solving?"

| | Percent of Total Group Responding |
|---|---|
| --Control<br>Includes:<br>a. Industrial control (service and installation)<br>b. Motor controls (hook ups)<br>c. Electronic controls (trouble shooting and circuits) | 35% |
| --Design and layout<br>Includes:<br>a. Reading of blueprints and schematic diagrams<br>b. Understanding of diagrams used by associated trades such as carpenters, plumbers, and sheet-metal workers<br>c. Knowledge of different methods of diagraming | 14% |
| --Basic electronics<br>Includes:<br>a. Familiarization with new tools and equipment<br>b. Use of test equipment | 11% |

c. Wiring and hooking up electronic equipment

d. New and better methods of installation

--Miscellaneous (less than 10%)

Includes:

a. Interpreting electrical code

b. Wiring disconnected machinery without a wiring diagram

c. Supervisory skills

d. Review of fundamental mathematical skills

# Appendix C

## PROGRAMING OBJECTIVES AND INITIAL REPROGRAMING ERRORS

# Appendix C

## PROGRAMING OBJECTIVES of Lesson 2
## on Powers of 10; Exponents; and Resistance Calculations

When the student has completed this section of the program he should be able to do the following:

- Give an example of a base and exponent, say what they mean, and write out the example as a group of factors
- Use algebraic addition
- Give an example of a base and negative exponent, express the example as a simple fraction
- Give an example of multiplication using exponents and a common base
- Give an example of division using exponents and a common base
- Give examples of addition and subtraction with powers of ten
- Give examples of multiplication and division using powers of ten
- Round-off whole numbers and decimal fractions to three significant figures
- Define resistance
- List the four factors which chiefly affect resistance
- Define resistivity
- Define mil
- Define circular mil and calculate the area of a wire in circular mils when given the diameter of the wire in inches
- Figure the resistance of a given conductor, using the AWG tables

## ORIGINAL OUTLINE FOR LESSON 2*
### of Journeyman Electrician Program

### Part I - Direct Current
### Section 3 - Electron Movement and Measurement (continued)

| | Frame |
|---|---|
| G. Ohm's Law | 437 |
| 1. Calculating voltage | |
| 2. Calculating current | |
| 3. Calculating resistance | |
| H. Cells in Series and in Parallel | 489 |
| 1. The effects on voltage | |
| 2. The effects on current | |
| I. Polarity | 510 |
| J. Test | 544 |

### Section 4 - Resistance and Conductance

| | |
|---|---|
| A. Math Review | 638 |
| 1. Powers of Ten | |
| a) Position exponents | |
| b) Negative exponents | |
| c) Using Ohm's Law | |
| d) Using the prefix kilo | |
| e) Using the prefixes meg, milli, and micro | |
| B. Summary | 743 |

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* Developed by U.S. Industries for their Tutor Film Program "First Year Electronics."

## INITIAL ERRORS IN REPROGRAMING OF LESSON 2*

1. Too much material in each step--the program does not test all the information given. As a result, if a student makes an error it is hard to pinpoint the reason for the error.

2. Not a logical progression. It does not work from the known to the unknown. The facts are disconnected or disjointed in their presentation. There are large gaps in the reasoning and some omissions which, in the absence of any information about prerequisites, seem unjustified.

3. From the foregoing, the student does not have an idea of where he is going. The program needs more "sign posts"--statements like, "We are now going to discuss . . . and show how this affects . . . "

4. Irrelevant operations are made too difficult. Why waste time on, for instance, multiplying in "longhand" when this is only a trick?

5. Definitions are not established and then pounded home.

6. Too few summaries and reviews.

7. Too many of the wrong answers are mere distractors and are not meaningful.

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* Identified by the programing consultant.

## OUTLINE FOR LESSON 2 AS REVISED*

For the Journeyman Electrician Program

(1) Introduction

(2) Laws of exponents
    Subsequences for (a) Algebraic addition
    (b) Negative exponents
    (c) Multiplication
    (d) Division

(3) Powers of ten
    Addition
    Subtraction
    Multiplication
    Division

(4) Significant figures and rounding-off

(5) Resistance
    Four factors

(6) Resistivity
    Definition
    Mil
    Circular mil
    Tables

(7) Practice, using Powers of 10 and wire tables from the National Electrical Code Book.

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* Based on suggestions of programing consultant.

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